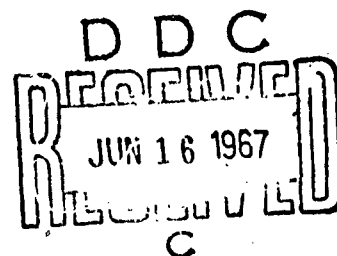# TEMPER as a Model of International Relations:

An Evaluation for the Joint War Games Agency Department of Defense

THE SIMULMATICS CORPORATION Cambridge / New York / Washington

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TEMPER as a Model
of International Relations:

An Evaluation for
The Joint War Games Agency
Department of Defense

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PREFACE

The Joint War Games Agency, which sponsored the development of the TEMPER computer simulation of international relations, has contracted with two organizations, each qualified in its own field, to evaluate the product. Mathematica of Princeton, N.J. was chosen to evaluate the game theoretic aspects of the model. The Simulmatics Corporation was chosen to evaluate the model as a representation of and tool for analysis of international relations. This document is the latter report.

It was prepared by a team consisting of Mr. Michael White, Mr. Michael Cook, Dr. Walter Clemens, and Dr. Ithiel de Sola Pool. All final judgements are those of Dr. Pool and are not necessarily all shared by all team members. Part III of the report, the detailed analysis of subroutines, is primarily the work of Mr. White.

The report consists of three parts:

        Part I   Overall Evaluation
        Part II   Evaluation of Major Assumptions
        Part III   Detailed Evaluation

PART I - OVERALL EVALUATION

The Joint War Games Agency is to be congratulated for sponsoring the development of the TEMPER model. It required courage to pioneer in something as "far out" is a computer simulation of international relations processes. There was a risk but the gamble payed off. The experiment worked. TEMPER is a functioning model. It proves that it can be done and should have been done. The first step has been taken in what hopefully will be a continuing effort by computer scientists and international relations specialists.

Because there are still sceptics and scoffers around it is important to emphasize what TEMPER is not. It is _not_ a prediction machine, a point to which we shall return later. It is _not_ flawless; most of this report will be devoted to picking over its flaws. It is _not_ a production model ready to be put to daily use by JWGA.

It is as if an observer were standing on the sands of Kitty Hawk on the morning of December 17, 1903. At the end of the few moments of clumsy flight the hypothetical observer, if a sceptic, might have asked, "Have any new principles of aerodynamics been discovered?" The answer would have been "No, it was simply a feasibility demonstration, applying principles long since known." The same is true of TEMPER. It adds nothing to international relations theories, it just uses them.

The observer at Kitty Hawk, if not a sceptic but an enthusiast might have asked instead, whether this new device the Wrights had built couldn't be used to transport people from city to city without roads or rails. The answer would again have been a vigorous no. That clumsy device with all the flaws and mistakes in its conception could barely get off the ground. That it could fly at all was remarkable. But as a means of transportation it was nothing but a promise on the horizon.

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So, too, with TEMPER. It barely flies! But that is a great achievement. On the other hand, anyone who thinks that it is going to do any production work for them in its present form would be as naive as our hypothetical observer at Kitty Hawk. Its accomplishment is that it exists and will provide a step in a long series of developments towards daily use of machine-aided cognition in the field of international relations.

It is almost a universal experience that when a highly complex computer system has been programmed for the first time through to operation, it should be immediately scrapped and reprogrammed. It is only by the actual programming of a complex system that one can begin to discover all the ambiguities, tautologies, redundancies, and naivates in one's earlier thinking. It is usually possible to vastly improve the efficiency, relevance and elegance of a complex program by throwing away the original working model and reprogramming. That is certainly true of TEMPER. If anything is done with it, it should be totally reprogrammed.

However, we would recommend an even more radical departure in future work. In hindsight it is possible to point out a major philosophical criticism of the approach used by the TEMPER designers. Where their goal should have been to develop a family of partial models designed for man-machine interaction in the analysis of international crises, they instead set out to replace the human analyst by a comprehensive computer model. The error is understandable considering the date when TEMPER was undertaken. There was little choice at that time. Appreciation of interactive man-machine systems is relatively recent, having become practicable only with time-shared computer systems. The point can perhaps best be made by reference to the analogous situation in machine translation. A decade ago many people believed that a computer program could be written to translate Russian texts into English accurately and economically. Despite extensive research in machine translation and linguistics, it is still true and will be for a long time to come, that human translators are

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both better and cheaper than computer translation programs. It has become obvious that the proper use of the computer in translation is as an aid to the human translator. Computer aided translation can be quite effective. Nonetheless, the early attempts at a pure computer translation device were by no means wasted, however mistaken the original hope may have been. Enormous progress in linguistics resulted from the research on machine translation. In the same way the attempt at a comprehensive computer model of international crises has advanced our understanding of international relations. It would be just as naive to say that the TEMPER research was fruitless just because the final conclusion is that it was attempting something that proved too complex for total accomplishment as it would be to say that computer-linguistic research has been fruitless because the final conclusion is that machine translation is too complex for present implementation. In both cases the attempt has been productive and has helped teach us how to produce a more modest computer-aided attack on the problem.

TEMPER as it now stands is quite modular. The various routines are separable, replaceable, changeable, without much difficulty. That is one of its strengths. Human intervention is possible at various points. In the reprogramming that was done between the original and revised version important steps were taken in this desirable direction. We are simply recommending even more radical movement in the same direction. In any future effort each routine should be developed independently as a device for producing some limited input to a human judge. Each should be played with, worked on, tested for realism and sensitivity, revised separately and only linked up afterwards, first pairwise and then in longer strings.

Many of the present TEMPER routines show us how to go about setting up these separate routines, and some show us - equally usefully - how not to set them up. A new start is not a start independent of the TEMPER study. It should build on it.

It is important to understand what TEMPER is for. Any computer simulation of real-life social processes can be used for one or more of three distinct purposes: prediction, training, or analysis. TEMPER is not a predictive simulation. To criticize it because it will not enable one to predict the course of an international crisis is absurd; it is true it cannot be used for such predictions, but no one should expect it to. Two facts limit the possibility of prediction: (1) the complexity of the system and (2) the recursive character of human planning which takes account of the prediction.

(1) As in any very complex system, what happens in the international political system is a product of two sets of facts: the laws that govern the system and the exogenous variables that provide parameter values. For example, what happens when a U-2 is shot down flying over the Soviet Union is a function of certain general characteristics of the sovereign nation-state system, some of the general characteristics of Bolshevism, etc. but also of the chance fact that the Soviet leader at that moment happened to be a rather excitable, bombastic individual compared to some other Soviet leaders, the chance fact that the American President at that moment was more direct and morally concerned in his response than some other individuals who have held the Presidency would have been, the chance fact that it happened on a day when a Head-of-State meeting was about to occur, and the chance fact that certain domestic political problems hit Khrushchev at the same moment.

A simulation of the consequences of a U-2 destruction done before 1960 might have produced quite a different history, and a perfectly valid one, for there was no one single necessary outcome to the shooting down of a U-2. The accidents of history chose one of these sequences in May 1960, but in a very real sense other outcomes were equally possible.

A simulation effort in an area such as international relations tries, step by step, to expand the model to incorporate more and more variables and thus to account

for more and more of the variance. Each subroutine is an attempt to explain another variable. Thus prediction gradually improves. But unless one fantasies about ultimately having a simulation of the entire universe, including for example, a subroutine to predict the decision-makers' mood that day, prediction remains an elusive objective.

2. Furthermore, the better prediction becomes, the more the players will deliberately take the prediction into account so as to falsify it. Let us illustrate the point by reference to economic prediction. Economics is a successful science. It would be impossible for a modern society to function without the knowledge that economics has given us. Yet economic prediction is not very good. One reason is that the economic system, like the international system, is very complex with many exogenous variables. But another reason is that when economists make a prediction people take them seriously enough to do something about it. There will, for example, never be a successful system of public stock market prediction. If some all-wise stock market predictor announced that there was going to be a crash in the market in 3 days, then the market would decline in one day as people sold off to beat his prediction.

Let us be clear then that prediction is the wrong criterion for a science that operates in public on major matters of human planning such as international relations.

If TEMPER is not a predictive model, what is it? The purpose of TEMPER is said to be "to provide an analytical tool for the study of global cold war conflict." The model "attempts to account for the interactions of all the nations of the world up to the point of general nuclear war, usually over a period of ten years." It does not explain which of three possible missions is primary: (a) simulation of the real world; (b) education of policy-makers and student; (c) strategic and foreign policy analysis. These three missions need not be mutually exclusive, but the requirements of the first are much more stringent than for the second or third tasks. For simulation of reality the model must be much more complex than if the purpose is to explore,

perhaps heuristically, the operations of world politics for the student or the researcher. TEMPER is above all an aid to understanding of the system that it represents. It is a device to help analysts conduct mental experiments on what kinds of alternatives history might offer. History offered just one variant of the many possible U-2 crises. Simulation provides a way of examining other possible alternatives, any one of which might have happened given other historical accidents. Most important of all, simulation is a way of examining the model (i.e. the theories) which we are using. The working of the simulation allows the analyst to learn what the model implies in a variety of circumstances. It is a way of forcing the scientist to improve the model as he rejects some of these implications as implausible.

For the scientist TEMPER is thus a learning machine. It is therefore also a teaching machine. The only questions are: at what level is it pitched, how good is it pedagogically, what lessons does it convey, what misinformation, if any, does it convey. We have not tried to answer these questions in any depth. Evaluation of TEMPER as a teaching device was not part of our assignment. To do such an evaluation would require observation of its use by actual students at different levels, something we did not do. All we can say is that TEMPER has considerable potential as a teaching device.

Our general conclusion, then, is that TEMPER is an important start in a direction that hopefully someone will continue. Clark Abt, its originator, the Raytheon Co., the contractor, the JWGA, the sponsor, all deserve the appreciation of students of international relations.

TEMPER's theoretical achievement may lie in its explicit modeling and operationalizing of a series of disparate variables that condition the processes of foreign policy making. While the result falls far short of establishing an isomorphic identity with the referent world, the conceptualization and graphic

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presentation of the variables in the system represent a great research achievement, one that could not help but make most observers more alert to the complexities inherent in world politics.

TEMPER is rationalist and scientific in spirit, optimistic that social problems can be understood and shaped according to reason. At the same time TEMPER is pragmatic, believing that if one cannot articulate the whole, he may nevertheless be able to work out its parts. And if he cannot fully comprehend the parts, at least he can simulate their behavior. If this simulation by surrogate "works," it is pragmatically good. The submodels of TEMPER (less so its basic assumptions) are non-dogmatic and open-ended, subject to revision after experimentation. The whole approach is oriented toward problem-solving, using heuristic devices, and any relevant discipline, to gain greater understanding and control of social processes. Finally, the whole TEMPER operation reflects positive cooperation between industry, government, and academia. It shows in a small way the possibility and desirability of relatively generous support for social science research. It symbolizes the determination of the U.S. government to base policy on science rather than intuition. On the other hand, TEMPER in its present form is full of the flaws and problems of any first effort. The rest of this report is a critical examination of some of these difficulties. Part II deals with some of the basic assumptions of the present model. Part III deals with particular subroutines.

PART II - EVALUATION OF MAJOR ASSUMPTIONS

1. Type of Crises Represented

A major ambiguity concerns the type of problem and the time-span TEMPER intends to analyze. Does it propose to study intense crises such as the Cuban confrontation of 1962 or longer term problems such as China's acquisition of nuclear weapons or the hypothetical results of a strategic arms reduction? Or does TEMPER plan to deal with both sorts of problems? The definition quoted above states that TEMPER accounts for interactions "usually over a period of ten years," but in the body of the document we see that it is also programmed to cope with problems that endure for less than a quarter year.

If TEMPER is to handle both sorts of problems, it should possess two distinct capabilities: (a) a facility for simulating the human and decision process variables that determine the denouement of an intense crisis; and (b) a program for anticipating the deterministic, objective forces as well as the voluntaristic, subjective factors that condition the international interactions over a ten-year program. Its original purpose was to simulate the long-term consequences of certain arms control measures, but the designers of TEMPER unfortunately yielded to a natural pressure to make TEMPER an instrument for anticipating the results of intense crises too.

2. Bipolarity and Aggregation of Nation Groups

Proposition: "There are two basic kinds of nations, neutral and bloc member, and all nations of a given kind have the same basic behavior structure although differences in emphasis may be very great." "Each bloc member is in one of two blocs (East or West), and to a degree is responsive to bloc goals and problems." (II-3)*

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*References cited in the form of a Roman numeral followed by an Arabic numeral are to the volume and page numbers, respectively, in the 1965 version of the TEMPER documentation (TEMPER, FR-65-174-1 to FR-65-174-7, prepared by the Raytheon Company for the Joint War Games Agency under Contract No. DA49-146-XZ-110).

TEMPER takes 117 real world nations and aggregates them into a maximum of 39 nation-groups. These are divided into 3 groups, the Western bloc, the Eastern bloc, and the neutrals. The geographic world is divided into 13 conflict regions, into each of which one can put a maximum of one nation-group from each bloc and one neutral. The constraints are such that conflict can only take place within a region, that the nations cannot be shifted from one region to another nor from one bloc to another. Since a TEMPER run lasts 10 years, this means that the world is locked for that period in the configuration originally devised by the player.

The tripartite division is good if one's major interest is the cold war nuclear stalemate, since it posits the possibility of major war only between the two opposing blocs, while the neutrals are the "swing vote" in peace-time politics. This makes the model fairly serviceable in situations like Berlin, Cuba, and Viet Nam. It would seem to be less suited to deal with intra-bloc crises like those in Hungary, Suez, Cyprus or the Congo, each of which probably had the seeds of international conflict in it.

The device of the conflict region is also basically good in cold war terms, since in a world restrained by a nuclear deterrent conflict is most likely to be consciously localized and even inter-bloc wars are going to be fought by proxy through local allies. What is not possible in such a world is conflict within one nation-group or internal war.

Such a troika classification has utility as a starting point for categorization. The TEMPER model is explicitly a model of the global cold war not of international relations generally. This is important to keep in mind, for other parameters such as "status quo" and "revisionist," "industrialized" and "industrializing," "Caucasian" and "Oriental," etc., may be equally decisive in shaping international behavior.

The assumptions of the TEMPER world do not permit the break-up of alliances and the collaboration between ideological adversaries that has occurred in recent

years. TEMPER would neither foresee nor permit the Sino-Soviet rift; polycentrism in Eastern Europe; or the withdrawal of France from NATO. TEMPER would probably permit the kinds of conflicts between neutrals that have strained relations in Africa and Asia in recent years, but its philosophy does not encourage thinking anticipatory of tension and alignments in the third world. To be more specific, the assumptions of TEMPER would probably not allow for de facto collaboration between Moscow and Washington against Peking, particularly if their actions were to aid India, and if their actions were welcomed by "neutral" New Delhi.

Still less does an absolute _troika_ approach foresee or tolerate the changes in world politics that come with such possible factors as (a) a further polarization in the "East bloc" as China becomes more powerful; (b) the rise of ten or twelve nuclear powers with a sense of autarky and non-alignment; (c) the decline of ideology; (d) a _boulversement des alliances_ and the creation of new alignments based on economics (haves vs. have-nots), race (white vs. colored), technology (nuclear vs. non-nuclear), or—what may sum up these differences—geography (north vs. south); (e) the possible repercussions of Malthusian pressures. This is a strength of TEMPER, not a weakness. TEMPER already attempts too much. Here at least we have one limitation, but one whose significance we must keep in mind.

TEMPER treats the _troika_ principle with appropriate moderation, saying that each bloc member is "to a degree" responsive to bloc goals, but to variable degree.

For generality in the application of the simplifications necessary, it would be better to reduce the number of nations whose behavior is simulated at one time and at the same time provide a more accurate representation of the behavior potential of whatever powers were relevant to certain crises. For example it might be both feasible and adequate to develop parameters on the five or ten greatest powers in the world. These data would be constantly available for simulations of different kinds. In addition, however, data might be developed

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ad hoc for another five or so nations that might be involved in whatever special problem was analyzed.

Ally Global Threat is a function of the military operations against one's allies. Yet no allowance is made for the fact that a nation-group may perceive several conflicts to be related, i.e., spawned by a single hostile force, or unrelated--i.e., the product of local conditions. In the former case the threatened nation-group is likely to percieve "I'm next," and in the latter case this is not so. TEMPER makes the former assumption.

There is no provision in TEMPER for supranational organizations (SEATO, CENTO). Such organizations may be simulated in a surrogate manner through (a) the proper drawing of conflict region boundaries and assignment to blocs and (b) the initial setting of ally value. That, however, is only partially satisfactory as a solution. TEMPER, because of aggregation, is very severely oriented toward a specific regional conflict problem, but conflict can break out in another simulate region. When this happens, it is likely that the conflict region boundaries, bloc structure, and ally values will be inadequate for realistic simulation of this conflict, and, a fortiori, that the outbreak of such additional conflict may be unrealistic precisely because of the factors just listed.

A nation-group's desire for military force is composed of the unweighted sum of the force it desires for use against its conflict-region opponents, and the force it needs for internal control.

This proposition takes into account the possiblity that a nation-group (NG) may not desire force for export. In the real world, few N.G.'s are satisfied with forces only for internal control.

We can note here that TEMPER, perhaps because of the limitation of war to conflict region opponents, reflects a nonexpansionist, non-imperialistic conception of the world.

If it is felt that this deficiency should be remedied, one way to do it would be to include a factor that is a function of the total ally value awarded by bloc members.

"A given Nation-Group can only make war within its conflict region, and is only threatened tactically by the other Nation-Groups in its conflict region. However, it can trade outside its conflict region and participate indirectly in conflict by shipping military forces to those Nation-Groups it wishes to support." (II-7) "Directed [or direct?] land conflict can occur only between Nation-Groups belonging to the same Land Conflict Region." (II-95)

The artificiality of dividing the world into Nation-Groups and conflict regions is strongly reinforced by the limitation that Nation-Groups make war only in their own conflict region. True, the dimensions of conflict regions may be altered; the limitation on "tactical" threat may not exclude a "Strategic" threat by the super-powers; and it is possible for exogenous powers to ship military forces to other Nation-Groups. But we may nonetheless speculate that the thrust of these limitations is to de-emphasize the actual capability of the great powers (especially the United States) for direct intervention in far-flung regions (possibly in several regions simultaneously), and to belittle the influence exerted by the strategic nuclear forces of the superpowers as a conditioning factor upon tactical encounters in third areas.

The unreality of the situation is increased by a logistic limitation of the model: military forces may be sent only by sea--a restriction that vastly minimizes U.S. freedom of option due to air lift [and, in the future, rocket lift] capacity. To make the problems more acute, the U.S.S.R. is defined in a land region by herself, with no ideological ally, adversary, or neutral. Similarly, the United States and Canada stand alone in their land region.

The documents give little instruction as to the most effective means for drawing one's map. They do warn of one technical restraint. "The user must establish his map and interaction variables not only to represent the situation he is studying, but also to respond to the detailed requirements of the computer simulation." If this precaution goes unheeded, "unrealistic events begin to occur and the simulation of the real world becomes less and less valid with the simulated passage of time." (II-9)

Basically, the bipolarity of the model rests on two facts: the existence of only two major nuclear powers, and the impossiblity of trade between East and West. Of these two, the first is most important. It is entirely possible for a major split in a bloc. However, this cannot happen without tinkering with the model. The non-competitive nature of the military aid routines, the difficulty of pursuing an international following, make it unlikely that a bloc split will occur unless it is intentionally made to happen.

The aggregation of nations raises several questions. If TEMPER is to be used for general prediction, it makes some sense to collect all the data that has been collected. But because nations are aggregated, it becomes questionable whether the precision of the calculations made with data-base variables is necessary. It is not at all clear that aggregation will give meaningful nation-groups.

General prediction is not one of the aims of TEMPER. Nation-groups must be drawn for a particular conflict problem. You can only aggregate those nations which are either unimportant, or those which are very similar, such as some of the African states. Otherwise, one must assume that a nation has very little individuality. It would seem that study of the impact of conflict in one area on conflict in another is one of the purposes of TEMPER. But, it appears from the TEMPER maps given in the documentation that while nation-groups can be set up in a reasonable manner for one problem, this forces an unrealistic aggregation in other parts of the

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world. Nation-groups that are secondary to the problem of interest become unrealistic, and the effects of primary conflict on these secondary nation-groups may be unreal.

Two other uses for the model may be considered. The first is using the model for testing and "building" theory. If one is interested in studying escalation, military aid and such, it then seems unnecessary to use large numbers of real nations, and both aggregation and the extensive data base seem unnecessary. For freedom of experimentation, it becomes necessary to be able to create many different situations that cannot be readily created with real-world data. If it is desired to study such problems in as realistic a context as possible, then it should be clear that the outputs are only as good as the weakest link in the calculations, and aggregation is inherently that weakest link.

If it is desired to study specific conflict problems, then aggregation represents a loss of power. TEMPER allows 39 nation-groups, and this number should be all that are necessary for any particular conflict. Why not just use 39 real nations? Aggregating all nations may lead to unrealistic conflict outside the problem area of concern. At the same time, aggregation causes the loss of information about the actions of important nations, as their individuality is lost in the aggregate. What is the point in aggregating Laos, Cambodia and Thailand when you are studying conflict in Southeast Asia, simply so that you can include African and South American nations which are entirely irrelevant to the problem at hand?

It seems to be unnecessary to include 117 real world nations in TEMPER, since the map is rearranged for each game in such a way as to satisfy the player's particular interests. In the map in Volume II on p. 8, all of sub-Saharan Africa is in one region, and all of Latin America in another. Including these two continents at that level of aggregation cannot add very much to the accuracy of political representation, and may even add unnecessary distortion in terms of the amplification

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of subjective player judgment in areas not in his focus.

It may be worthwhile to consider rejecting aggregation in favor of either semi-abstract nations, if general research is desired, or in favor of specific nations, if policy research is desired. The former strategy would allow increased detail for the specific research question at hand; the latter would allow greater detail for the study of a specific conflict problem. It is unrealistic to hope that we know enough about the world to be able to simulate it accurately in entirety. The strategic simplification to either research problems or to specific conflict problems should allow the model to give more useful and more valid results.

3. Nations are Units

"Each nation has goals and ideals, and its perception of the divergence between the actual state of the world and the ideal state is the motivating force which causes it to modify its behavior." "These behavior modifications seek to reduce the divergence between the actual and the ideal in the period ahead." (II-3). TEMPER is a model in which nations are units.

These propositions assume that unanimity prevails within the decision-making body of each nation. In the real world, there are divisions of opinion, if only as to priorities or means to an end. There are differences arising from conflicting economic, political, and social interests; from the conflict of generations; and from the temperaments of the persons involved. Even where one political leader, such as Stalin, has virtually absolute power, factions will compete to influence his attention span, his priorities, and his final decisions. Even without these external pressures, the top leader will suffer from cognitive dissonance that makes him "of two minds" on various issues.

This assertion about the general population is, of course, a drastic simplification. To look at a current example, it is clear that U.S. public (and Congressional) opinion is divided into those who would prefer escalation in

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Viet Nam; withdrawal; or neither. Domestic pressures can crucially affect official policy. Hanoi apparently believes they could be decisive, and acts accordingly.

The axiom "divide and conquer" continues to inspire foreign policy, if under the Leninist idiom of "exploit internal contradictions." Similarly, the very existence of The Voice of America indicates that Washington does not believe the Soviet Union to be an invulnerable monolith.

The designers of TEMPER are to be congratulated for avoiding the temptation to get into those complexities too.

So far we have discussed only one aspect of a longer spectrum, namely, heterogeneity of opinion within a more or less stable political system. At the other end of this continuum is civil war, accompanied perhaps by foreign subversion. Somewhere in between these points are labor strikes and race riots. "Internal war" is surely a salient factor in world politics, and subversion of existing governments, perhaps with external aid, is a major policy problem that should be part of future development of a simulation of international relations.

In U.S. history, for example, the divisions and the mood of public opinion seem to have contributed to cycles of pacifism-bellicosity and isolationism-commitment.* To forecast U.S. policy one must study directly the coefficients and thresholds delimiting these swings in U.S. opinion and public policy. Similarly, if one wishes to determine the viability of a given foreign policy on the part of a developing country (say, Nigeria or South Viet Nam), one must examine in detail its internal stability.

In evaluating what has been done so far, we welcome the simplification that nations act as units, not the simplification that nation-groups act as units, and

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*Cf. Walter Lippmann

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urge that an early next step is getting away from both present simplifications to allow for representation of internal divisions and civil conflicts.

4. Cultural vs. Material Factors

There is elemental truth in the assertion that individuals and governments seek to reduce the gap between perceived reality and their goals. But this truth does not mean that an outsider will be able to calculate the response of governments to external events by assuming a rational decision-making in the game theoretical sense. The government involved may not have perfect knowledge of the situation, just as the outside analyst may not have a complete picture of the mind of the government officials. To give an example, Washington may contend that the M.L.F. is in the Soviet interest, because it prevents an independent German finger on a nuclear trigger;* the Kremlin, however--perhaps for "irrational" reasons--deems otherwise.

It may be that governments should--in their own interest--attempt to maximize their goals by rational calculation. It may also be that they will tend to do so increasingly. In the U.S. government, for example, cost-effectiveness techniques are being attempted in realms far removed from their first application in defense problems.** But the time when the main lines of U.S. policy (not to speak of the policies of other states) is determined by a highly rationalistic approach is quite distant. Even if it arrives, the outside analyst will still have the problem of calculating the options as the government involved sees them. And he will still be confronted by the fact that each government and individual is subject to various cross-pressures that give rise to logically contradictory policies. TEMPER is, as it should be, in all these respects a simplification of reality.

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* Cf. Brzezinski in <u>Foreign Affairs</u>.
** Cf. <u>Foreign Affairs</u>, October 1966.

Prediction on the basis of the "logic-of-the-situation" will always be precarious.* Past behavior patterns may afford a much sounder basis for political forecasting than attempts to calculate the options as decision-makers see them.

In short, the rationality model is a hazardous guide to prediction. Influences may derive from many sources--the psychic needs of the political leaders, their political tradition and culture, their economic interests, etc. A variety of forces arising from within the individual, from his environment, and from his every action contribute to inertia or to momentum that may be in conflict with pure rationality. Added to these factors is another which also impedes rationality, namely, imperfect knowledge of the opportunities and restraints inherent in the real world.

Among these, TEMPER emphasizes economic and strategic factors over cultural and psychological ones. It represents a world, (a) that is black, white, and neutral; (b) in which nations' allegiance is always for sale; (c) in which U.S. strategic doctrine (counter-force rather than countercity; the feasibility of limited war and the unlikelihood of escalation, etc.) is accepted by the adversary, even if he does not admit this. In TEMPER foreign problems are susceptible to solution by military and economic means, without much concern for ideology or social reform.

The TEMPER design quite properly seeks to qualify unbounded faith in its basic rationality principle. The operation of TEMPER commences with a "psychological submodel" that perceives threats and other exogenous problems, and reacts to them in light of cultural-ideological characteristics unique to the particular nation, taking account also of distortion in the perception and communications about it.

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*Cf. Alexander George, Propaganda Analysis

This mechanism,however, is an adequate half-way house for accepting some factors that are outside of its basic design. This mechanism says that decision-makers receive their values from their environment. TEMPER still assumes that leaders act rationally to maximize these values.

A simulation of international relations could take account of behavior which is irrational by projecting directly from past behavior patterns rather than positing rational decision-making. It might even inject at random actions which seem to run contrary to historical trends as well as to rationality.

5. Mathematical Functions

TEMPER attempts to be too quantitative. There are many phenomena that can be ordered or otherwise described in rough quantitative fashion that cannot be measured with exactness. For example, it is usually possible for persons (including national decision-makers) to say which of two alternatives they prefer. It is usually impossible for them to say exactly how much they prefer one to the other.

There are substantial branches of psychology, economics and applied mathematics that operate on ordinal data where more informative quantitative information is lacking. Game theory is such an area. Since the Mathematica report is on this subject and will presumably dwell in detail with the matter of how fruitful deductions could be derived from the limited information available about international relations, we shall not discuss the matter at greater length here. Suffice it to say that no useful purpose is served by inserting arbitrarily chosen numerical values or continuous variables when one has no idea whether they are right. It is more fruitful to design the model so as to see what conclusions can be reached from weak assumptions.

Examples of some of the purely arbitrary quantifications in TEMPER follow:

The tactical threat to a nation-group in its conflict region is

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For a bloc member

> 2/3 the figure calculated for threat from the
> opposing bloc member

> +1/3 the figure calculated for threat from the
> neutral

For a neutral

> 1/2 the figure calculated for each bloc member.

HOSTIL is a function of TACTIT multiplied by 5 (Why 5?)

THREAT is 2/3 military threat and 1/3 political. (Why that ratio?)

WILLINGNESS is calculated by an equation with 6 weights, all arbitrary.

ZMILI is 10 times the fraction of one's budget initially desired for defense.

Disutility in the sum of terms one of which is the total losses in the war
today times 100.

The escalation key is set to 1/10.

Depending on a situation calculated in WINIT MIL-OPS may be raised or lowered
by .05 times the cube root of the problem. (Why .05?)

6. Documentation

The TEMPER documentation is generally poor in explaining itself, both in its
definitions and qualification. It is not only turgid and unclear in many places
but it leaves a great deal unsaid and undefined, so that one is often misled by
words which have a more restricted sense in the TEMPER documentation than in the
general literature.

The following is typical of TEMPER writing:

> The [power ratio] motivation is computed by finding the deviation
> from the aspiration level, assuming no threat. The aspiration
> levels are similar to the static motives and limit. They are
> assumed to be different for each bloc leader and are set as
> parameters when the Data Base is set. In the current Data Base,
> they are set so that there is a greater range (?) of aspiration
> levels for the U.S. than for the Soviet Union, and therefore a
> greater sensitivity and response to threat. Lack of threat drives
> the function to one level. Threat drives the value toward a second
> aspiration level. (II-56)

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Granted it is hard to write-up a complex model in clear English. That indeed is the reason for turning to flow diagrams and computer programs. The numerous branch points, permutations, and combinations do not permit a lucid literary description of the system. As the TEMPER documents put it,"...there is no way to describe the details of the hundreds of formulations /in the structure of the model/ in a way that is both brief and complete." (II-22). Nevertheless the documentation could and should be much better presented.

What the documentation claimed a variable represented was often not what it represented. Interpreting the variables was very difficult. What might be called hostility was not necessarily an adequate operationalization of hostility, for example. The psychological operations variable can be interpreted in several ways, and is in fact used as if it meant several different things. One often had the feeling that a variable was being used as a surrogate for more than its definition implied, and yet was often unable to figure out exactly why the designers were using it. Almost no justification is given for any of the routines or equations. The documentation never says that it is doing something in order to simulate the effects of something else. Instead, all that is given is the names of the TEMPER terms.

At times we have had to resolve contradictions in the documentation on the basis of shaky evidence. The documentation has many misprints and misrepresentations. The latter are more characteristic of volume II, the former of volume IV.

TEMPER is quite novel in the constructs it uses (such as the problems), highly specific, and in major decision routines somewhat artificial. That is not necessarily a defect, but it does call for explanation.

7. Contributions of the TEMPER Model.

The progress registered in the TEMPER structure can be better appreciated if viewed in the perspective of the overall evolution of international political theory.

Most writing has been narrative description of historical events.* Analytical

work has usually focused on one or two factors assumed to be decisive; grand

explanations have usually been rooted in an a priori hypothesis which is plausible

but which remains unproven by methods capable of replication.** More recently, partly

in revolt against fashionable but simplified theories of power-maximization,*** and

partly in tune with the march of the scientific Zeitgeist, some writers have developed

a systems analysis approach to the study of world politics.**** This approach appears

potentially quite fruitful, but so far it has little empirical foundation and still

less operational utility. From another direction we see developing a multi-discipli-

nary approach intended to deal with functional problems such as nation-building, an

approach that draws on the insights of various disciplines, but which has not yet

ventured to separate, weight, and generalize about the variables treated.*****

While political science generally is just coming to an appreciation of systems

approaches, and while it has achieved as yet little symbiosis with the other

disciplines needed to deal with international problems, the TEMPER model has already

provided a system of mechanisms creating from building blocks of various disciplines

a coherent whole. Its structure first isolates and then connects mechanisms intended

to simulate the many dimensions of world politics. Not only is there an explicit

sequence of subroutines incorporating mechanisms for the simulation of threat per-

ception, national character, economic strength and propensity, military logistics,

and bargaining and overall strategy formulation. There is also provision for the

workings of these forces over time. In its temporal extension the TEMPER model

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*This has been especially true in studies of diplomatic history, international
law, and international organization.
**Cf. Gibbon and Toynbee.
***Cf. Morganthau.
****Cf. Kaplan
*****Cf. Millikan and Blackmer, The Emerging Nations.

describes the world in a form that is modified week by week to reflect the response that each Nation-Group is expected to make in each of several different functional areas. For example, the psychological subroutine commences with a threat on day zero and evaluated the threat by mechanisms intended to simulate the process of national perception and experience; KULTUR subroutine comes into play only if the problem lasts for more than a quarter year. Similarly, the decision making subroutine moves directly from DMFILE (decision-maker file) (II-16) to WEBARG (bargaining control) unless a half-year passes, in which case it goes first to STRDM (strategic decision maker). The positive aspects of TEMPER represent a kind of leap forward in the explicit formulation and expansion of international theory despite defects inherent in the simplifications in the model's basic assumptions.

MAJOR RECOMMENDATIONS

1. Combine SHIFT, REMOVE, LIANCE, XLIANCE, and WINOVR to make a single routine for the calculation of military aid.

2. Completely rework CONTRA, TRADER, and WINECO.

3. Tidy up the THREAT routine. The mathematics of strategic threat defeats the purpose of some of PERCEP/XPERCE.

4. All weekly problem components in PROREC are unnecessarily complex.

5. Simplify WINIT.

The basis for these recommendations is our analysis of the assumptions and propositions explicitly or implicitly incorporated in the TEMPER documentation. These are discussed in detail in the following report, particularly in Part III.

Throughout this document some abbreviations, other than FORTRAN variable names, were used:

A/A value	Ally or alignment value (friendship value)
AGT	Ally global threat SUM (L,G)
CFU	Counterforce utility
LCR	Land conflict region
Mil Aid	Military aid
MIL OPS	Military operations level
PRM	Power Ratio Motivation, XMPWRZ
N.G.	Nation group
PSYCH OPS	Psychological operations level, or threat level ZPSYZ

THREAT

TEMPER is divided into four submodels, psychological, economic, war, and decision making.

The psychological submodel is designed to simulate the following in international politics:

    a. Communications channels
    b. Diplomatic channels
    c. Intelligence Networks
    d. "Feelings" that Nation-Groups perceive
    e. National culture and basic national motivations.
    f. The threat a Nation-Group feels.

The first three elements are all included as sources of perception distortion and the second three as the subjective outlook of nations which result in compatible demands, misunderstandings, and conflict. These are probably adequate for the model, though as has been pointed out the cultural characteristics of each nation-group are oriented to military rather than ideological problems. Again, in terms of a cold war conflict model, ideology may not be very important, but the demands of political cultures may well be such that nations must be described on different scales rather than simply being assigned various positions on any one scale.

Subroutine THREAT in the psychological submodel calculates both military and political threat, and on the whole seems to be cogently formulated. Military threat is composed of tactical threat, computed weekly, and strategic threat, computed quarterly. The equations for tactical and strategic threat seem to be adequate for East-West tensions, even when these may be symbolically represented in some remote corner of the TEMPER map. Several cautionary remarks should, however, be made.

First, the calculation of tactical threat involves only a comparison of force ratios and a perceived level of opponent military operations. The word "opponent"

(like many, many others in TEMPER) is used loosely and without definition. It is, presumably, the member of the opposite bloc in the same conflict region, which means that in arranging the map one is doing more than merely determining political preferences. You are automatically putting the nations in each region at each other's throats, if indeed the military operations level is greater than zero, or else you must put the non-involved nations in the neutral group. This is either a weakness of the mapping system or of the calculation of threat.

There is a further difficulty in the meaning of the words "tactical" and "strategic" as used here. These words seem to be as much dictated by the military constraints in the TEMPER world as by more meaningful considerations. Conventional wars can only be fought within conflict regions, so tactical threat is similarly confined. This represents a geographic rather than military distinction from strategic considerations which are related to nuclear attack and thus only to the major bloc members (II-30). It does not make much sense to distinguish between tactical and strategic threat in this way, since all nations to some extent live under some nuclear umbrella and all feel a threat therein. Not all nations may act to change strategic threat but all can be either restained or unleased by this tension (the whole problem of the tail wagging the dog in modern nuclear politics is not dealt with in TEMPER, which is perhaps a flaw but too complicated to include and not always relevant to U.S. - U.S.S.R. problems, except probably in the case of Cuba). Tactical threat to all nation groups:

TACTHT is calculated through an Arc Tan function of the perceived Mil. Ops. level of the threatening nation minus the CFU ratio of the threatened over the threatening. A perceived figure is used for the latter.

$$\text{TACTHT} = \text{TAN}^{-1} \left(\text{XDOMPZ(ND,J)} - \frac{\text{XCFUZ(L,J)}}{\text{XCFUPZ(LL,J)}} \right)$$

This equation is bounded between $\overset{+}{-}.5$.

The tactical threat to a nation group in its conflict region is computed weekly, summed and averaged over 12 weeks, giving a quarterly figure. The weekly figures are not used.

Several things are questionable here.

(1) Use of the Tan^{-1} function means that TACTHT, and thus the averaged quantity PSWWAR (L,J) is most senstive to changes at the middle range of the argument of the TAN^{-1} function (the argument is scaled this way. See IV-39), in other words when XDOMPX, the perceived Mil. Ops. level is around 5, its mid-value.

(2) TACTHT is strongly a function of the military operations level and only weakly a function of CFU ratios. The CFU ratio is scaled between -1 and +1 while XDOMPZ can range from 0 to 10.

(3) No allowance is made for psychological operations as a factor in tactical threat--threats, accusations, protests, economic competition, provocations and such, either governmental or private.

(4) The different weighting of threat from conflict region opponents depending on whether the threatened nation-group is a neutral or a bloc member seems a simplification based on an inflated notion of bloc cohesion. Among the factors that might be relevant in weighting conflict region opponent threat are the propensity to use military coercion, ZMILC, relative size and resources of the two nations.

Tactical threat is thus a function of two current aspects of the environment: CFU ratios, and opponent military operations. It does not seem unreasonable to introduce a permanent component to tactical threat somewhat on the lines of Chadwick's national security index:

$$\frac{A - B}{A + B}$$

Where A is the distance from the opposing bloc leader and B is the distance from your own. For neutrals this could be adjusted to measure distance from both. The point is that there is some inherent threat to a nation like CUBA that is probably considered by the player when setting initial values for a data base variable. This is an unsystematic way of doing it. The proposition here is that a nation will feel threat if, as a member of one bloc, it is far from its bloc leader while close to the opposing bloc leader, and this threat is tactical. The existing tactical threat equation could be used to calculate a dynamic component of tactical threat.

STRATEGIC THREAT, STRAT, is a function of 3 factors:

(1) A bloc credibility function which suggests the likelihood of nuclear war as a function of military operations levels and population loss ratios.

(2) The population loss fraction for the target bloc.

(3) The particular credibility a nation group places on nuclear war. These three need to be explicated.

(1) The bloc credibility function: the population loss ratio is calculated for an opponent counter-force preemption against the bloc, with several exchanges. The population loss fractions are computed in STRDM, and are determined according to data on types and hardness and number and accuracy of nuclear weapons, and fallout characteristics and such. As this seems a military matter we have omitted evaluating it, and have accepted their calculations of the fraction of population lost by the bloc due to opponent preemption. The calculation is quite complex, yet it is decomposable and thus evaluable.

The ratio of the fraction of bloc A's population lost if bloc B preempts, divided by the fraction for B when B pre-empts is manipulated from limits of .01 and 10 to limits of 8 and 3 through the following discontinuous transformation:

$$\text{SDAMAG} = \begin{cases} 8-3.5* \text{SRATIO}, & (\text{SRATIO} < 1) \\ 4.5- .15* \text{SRATIO}, & (\text{SRATIO} \geq 1) \end{cases}$$

$$\text{SRATIO} = \frac{\text{Fraction of A's population lost when B pre-empts}}{\text{Fraction of B's population lost when B pre-empts}}$$

Because of this, a nation-group is more sensitive to changes in a favorable population loss ratio. The complete factor is:

$$\frac{\text{DOMAX} - \text{SDAMAG}}{10 - \text{SDAMAG}}$$

This term cannot be negative. DOMAX is the maximum MIL-OPS level anywhere in the TEMPER world that the national group under consideration perceives. That nation group will feel no strategic threat unless DOMAX exceeds SDAMAG. The more favorable (lower) the population loss ratio the higher DOMAX must be for strategic threat to be felt. Further, the less beneficial a pre-emption will be for the enemy, the lower will be the strategic threat that is felt. (Note that SDAMAG is inversely related to the population loss ratio.)

The likelihood of nuclear war, as perceived by a NG, is dependent on the maximum military operations level in the world, and the advantage that would accrue to a pre-empting opponent.

(2) The bloc credibility function is multiplied by the population loss fraction. This means that STRAT is a function of the likelihood of nuclear war, as calculated in the bloc credibility function, multiplied by the population loss that would result were there to be a counterforce pre-emption by the enemy bloc.

(3) For strategic threat to a nation group (bloc member), the above quantity is multiplied by XCRED(L,J), a parameter set by the player, which determines the credibility that that nation group places on nuclear war.

STRAT = (bloc Credibility Function) (population loss fraction due to opponent pre-emption) (nation-group's credibility parameter)

This variable involves a quite radical simplification. Once again one can perceive the effects of the bipolarity of the model. There is the implicit assumption that a bloc leader will be perceived to be as likely to initiate a nuclear exchange as a result of conflict on one region as in another.

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One may not safely assert that perceptions of the likelihood of nuclear war are independent of where the maximum perceived MIL-OPS are without asserting this dubious proposition. It is, for example, unlikely that the Soviet Union will preempt as quickly due to South East Asia conflict as they might for a European conflict, and it is, it follows, unlikely that the Western bloc would perceive a Soviet pre-emption as equally likely in either case.

Thus some allowance should be made for the region where DOMAX happens to be. Some consideration of the ally values between bloc leaders and conflictors might be enough to improve this situation.

The XCRED(L,J) parameter is set by the players, presumably because it is not clear what this parameter represents. Neutrals feel no strategic threat. Yet, it would seem that if the targeting is counterforce, then a bloc member without nuclear weapons will have no greater feelings of strategic threat than a neutral.

POLITICAL THREAT

Ally Global threat: SUMA(L,JJ). Computed weekly and summed and averaged for a quarter. Bounded by .5 and 0.0.

$$SUMA(L,JJ) = \sum_{N \ WEEK \ = \ 1}^{12} \sum_{ALLY \ = \ 1}^{n \ = \ 10} ZFVAL(JPAP)\left(\frac{TACTHT_B + TACTHT_N}{120}\right)$$

SUMA(L,JJ) is the sum of the tactical threat to each ally both from the opposing nation group and the neutral in that ally's conflict region, equally weighted, modified by the value of that ally, and averaged across allies and along weeks.

Thus it is a function of the average tactical threat to each ally for the quarter times Ally value.

This average tactical threat is itself averaged across allies for scaling purposes.

The fixed divisor of 120 is questionable. First, the number of countries one may assign ally value to is limited to 10. Second, if a country assigns ally value

to less than 10 nations, AGT is still averaged as if 10 nation-groups had received ally value. Implicit here is the proposition that Ally Global Threat is a function of the number of allies a nation has.

The importance of AGT can only be that it measures the likelihood of getting drawn into conflict through an alliance. Several points therefore need to be made.

(1) There is no provision in TEMPER for supranational organization. (SEATO, CENTO).

(2) Questions can be raised about the way in which ally values are set into the data base and the way in which they are aggregated.

(3) Ally Global Threat is a function of the military operations against cne's allies.

(4) This quantity cannot be computed for neutrals.

Influence Threat from Allies and Neutrals

Influence threat results only from decreases in ally alignment value awarded to a bloc member. The incremental decrease in ZFVAL and ZFPAP that is automatically calculated in DMFILE is not included here. Only declines that result from economic and military policies of the nation-groups are included here.

Several propositions emerge:

(1) Influence threat is a function of decreases in ally or alignment value only.

(2) Each decrement is multiplied by the absolute value of the present ally or alignment. Therefore the higher the ally or alignment value originally the more serious the decrease.

(3) The contribution to influence threat from neutrals may be no more than a value of 1/6; from allies, a value of 1/3. Therefore contributions from one's allies, although calculated in the same manner as from neutrals, may be twice as much. It is hard to see the justification for this. If studies can show that

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contributions from allies are twice as important, then could be weighted as well as bounded accordingly.

Influence threat from an ally or neutral increases with the <u>square</u> of the <u>initial</u> value assigned by the ally or neutral, for a constant fractional decrease

$$\frac{(\text{OLD VALUE} - \text{NEW VALUE})}{\text{OLD VALUE}} = \text{CONST}$$

Influence threat is a quadratic function of the decrease in ally or alignment value, and is a maximum when $\frac{(\text{OLD VALUE})}{(\text{OLD VALUE})} - \frac{(\text{NEW VALUE})}{(\text{OLD VALUE})} = 1/2$, and is zero for either total change or no change.

Some questions need to be raised.

One wonders why the withdrawal of all ally value by an ally (or alignment, of course) should make no contribution to influence threat, since this would reflect a great loss of influence.

Stated here is the hypothesis that a bloc member is threatened by withdrawals of ZFVAL and ZFPAP, and not by changes in the amount of ZFVAL and ZFPAP assigned to it. In other words, a bloc nation group cannot decrease its feelings of threat by inducing some neutrals and allies to award it increases in ZFVAL and ZFPAP, no matter whether the increases are awarded by powerful friends and withdrawal of points is done by weak friends. Influence threat is not a measure of loss in total influence, as measured by received ally and alignment value.

THREAT, for a bloc member, has two components: military and political. These two components are combined and used in KULTUR. In summary we can say that threat is composed of tactical threat in the conflict region, strategic threat, political threat from tactical threat to one's allies, and the influence threat resulting from decreases in ally and alignment points.

Tactical threat is an arc tangent function of the perceived military operations levels of conflict region opponents minus the counterforce utility ratios scaled

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from -1 to +1, and is thus far more sensitive to MIL OPS than to CFU ratios. The arc tan function makes TACTHT most sensitive to changes around median levels of (XDCMPZ - CFU ratio), or around MIL OPS levels of 5. For a bloc member TACTHT from the opponent bloc member in the LCR is weighed twice as heavily as TACTHT from the neutral.

Strategic threat to a nation group is a function of the possibility it perceives of nuclear war, _times_ the fraction of bloc population that would be lost in the event of an opponent pre-emption, _times_ an assigned parameter which represents the credibility that the nation-group places on nuclear war in general.

The perceived possiblity of nuclear war increases linearly with increases in the maximum perceived mil ops level of any opponent bloc member, and decreases as the population loss ratio decreases, though in a non-linear manner that we have not worked out.

Threat to a neutral is calculated differently from threat to a bloc member.

(1) In tactical threat, the contributions from conflict region opponents are weighted equally. The assumption involved here is that neutrals will feel equally threatened by either bloc member, regardless of alignment values, bloc cohesion, etc., while a bloc member weights the threat from an opposing bloc member twice as heavily as a threat from a neutral.

(2) Strategic threat is not calculated from a neutral. Therefore all military threat to a neutral is tactical (PSWWAR) = (TACTHT).

Political threat to neutrals is calculated quite differently from political threat to bloc members. It is calculated by subtracting the quantity one minus external dynamism (ZEXTD) from each award of alignment value and summing the positive differences.

A neutral feels threatened if it has assigned a bloc member alignment value in excess of one minus ZEXTD. The higher one's ZEXTD, the less alignment value

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that can be assigned without causing threat. The magnitude of this threat is the excess over the threshold of 1-ZEXTD. This, though artificial, is reasonable, for 1-ZEXTD is as good a threshold as any.

Alignment values are also updated here. First, values that are too high are reduced by .05 times the square of the sine of the argument, excess multiplied by π. The documentation argues that multiplying by π converts the excess to radians. This is an error, and instead π must be considered a scale factor. This scale factor causes the reductions to be less if the excess is .6 than it is if the excess is .5, and should be discarded. (For the sine of .6 is less than the sine of .5 (or π 1/2), a maximum.)

As it is now, retractions increase until the excess reaches .5, then they decline. There is no reason given for using sine squared, and no reason is obvious. As the sine is roughly linear over the range of most probable excess values, and as the process here is supported by no research we know of, there seems no reason not to make these declines a linear function of the excess, or possibly to just wipe the excesses out completely, or maybe to prevent them in the first place.

If a conflict region opponent is perceived to have a CFU ratio of 3 to 1 over the neutral, and his perceived desired land fraction plus the tactical threat from him exceeds .5, the neutral is forced into alignment with that conflict region opponent. The neutral must increase his alignment by the product of the unassigned alignment value (1-ZFPAP_ and the hyperbolic tangent of .025 + ZFPAP. Thus neutrals must align themselves with strong and threatening conflict region opponents, and the less they are presently aligned, the more so they must become.

This would make a great deal of sense were it not such a function of the TEMPER map. A neutral may have a strong opposing bloc member next door in the next conflict region. Or, it might be strongly aligned with the opposing bloc. Further, it is conceivable that a neutral might be forced by these propositions to become

closely aligned with two conflict region opponents. This is an inconsistency. Both these updating routines make some sense, but both have flaws.

Threat to neutrals is the sum of tactical threat and of political threat, weighted equally. The former may not exceed unity, the latter is unlikely to do so; therefore both terms are probably of the same order of magnitude.

PERCEP and XPERCE

TEMPER states that "open societies are less likely to obtain information about closed societies than vice versa" (II-40), which may be true in quantative terms but not qualitatively. Political perception is clear and more accurate in the other direction, precisely because open societies are somewhat less victims of their own ideological views.

Intelligence networks receive both overt and covert information; the former is likely to come more regularly than the latter, but it is not so likely to be accurate. (II-23,40-49.) This assumption cannot be accepted as a generality about the real world.

Perhaps in a restricted meaning this could be defended. But overt information in the form of mass media communications can be quite accurate, particularly if the analyst recognizes its potential limitations.

The trained analyst may obtain from it more certain knowledge than would be available from clandestine agents. Conversely, certain kinds of covert information are received at frequent intervals, while interesting insights from overt sources may be highly random. Thus, photos from a reconnaissance satellite might be quite regular as well as quite accurate.

PERCEP sets up the calculations for execution by XPERCE. Certain variables describing the opposing bloc leader or nation-groups are perceived and distorted.

Perception has two components:

BIAS: The real value of the variable is subjected to bias. Bias is obtained by multiplying the real value of the variable being perceived by static bias, raised to the power H: B^H= BIAS

Static bias, B, is set by the designer.

DISTORTION: is stochastically determined, and is a fraction of the real value of a variable that is added to or subtracted from the biased value.

(1) PERCEIVED VALUE = BIAS (REAL VALUE) + DISTORTION (REAL VALUE)

The following variables are perceived:

XQGOV   Government Expenditure/Quarter

XQMIL   Military Expenditure/Quarter

XQRES   R and D Spending/Quarter

XQSTR   Strategic Spending/Quarter

XQTCA   Regional tactical O and M cost/Quarter

This is the bloc leader budget bargaining array, the array of values about which the bloc leaders may bargain. It is, therefore, an implied proposition that these are the only variables over which the bloc leaders may bargain. In fact, only the last four of these variables are bargained over. It should be noted that

XQMIL = XQRES + XQSTR = XQTCA   but instead

XQMIL = XQRES + XQSTR + XQTCA + CPRO

CPRO = $ for tactical force procurement

While it may be acceptable to limit bloc leader bargaining to problems resulting from force budgets (though we doubt it) no reason is given for the selection of these four variables. That is, why is <u>tactical force O and M cost perceived, but strategic force O and M and procurement cost</u> not also?

(2) XMPWRZ (LM, IPM) - Power Ratio Motivations for the bloc leaders.

For each bloc leader, his spending desires are expressed as the following ratios:

XMPWRZ (1) = XQRES of one bloc leader; XQRES of opposing bloc leader

XMPWRZ (2) = XQSTR "   " "   " ; XQSTR "   "   "   "

XMPWRZ (3) = XQTCA "   " "   " ; XQTCA "   "   "   "

The rest of the preceived variables are for the use of all nation-groups.

(3) XCFUZ - Value of military forces of conflict region opponents, in CFU.

(4) ZDLND - fraction of the conflict region the conflict region opponents desire.

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(5) ZDOMZ - opponent's MIL-OPS levels

(6) ZPSYZ - the level of MIL-OPS the opponent is threatening, or PSYCH-OPS.

Variable arrays (1) and (2) are preceived by the bloc leaders. (2) is also perceived by strategic force owners.

Variables (3) - (6) are perceived by all nation-groups.

For interaction between nations, no other perceptions are necessary, except for ally and alignment values, which are perceived accurately. It is questionable whether the accurate perception of alignment value is realistic: i.e., perceived ZFPAP = ZFPAP on the part of bloc members, but the variability of alignment value probably reduces the discrepency between perceived and real values to an acceptable minimum.

These perceived variables control much of a nation-group's behavior, and because of this, they should be very carefully considered in themselves.

The general distortion equation is the following:

$$V_N = (B^H + \sigma R) V_{R'}$$

V_N = New Perceived Value

B = Static Bias

H = Hostility

R = Random number

σ = Standard Deviation of the distortion of V

R' = Real value of variable at time of perception.

The documentation incorrectly states (IV-68) that the perception operator, $(B^H + \sigma R)$ operates on the old perceived value. This is incorrect. If the program did this there would be no reason to use the parts of XPERCE that decide whether new information was received, for no new information would ever be received.

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Checking the program listing one finds that real values are set into an array called TEMP and perceived values in a STORE array. It is TEMP that is used in the perception equation (IV- 72) and program listing.

PERCEP prepares the arrays for XPERCE. XPERCE decided whether the perception equation should be used, and then uses it, accordingly, updating the STORE array.

The key to the perception routines is the perception equation given above. The basic proposition is contained in the equation, which states that the perceived value of a variable is the product of the real value and a bias factor (a different constant for each of the six types of perceived values, raised to a power between zero and ten) and added to this product is a random distortion factor, which is a fraction of the real value.

This fraction may not exceed $\pm$ .192 with the standard deviations as they are now set by the designer into the data base, and with the present value of the constants that are used in the distortion part of the equation. The lower limit on distortion is $\pm$ .000036 of the real value.

Let us consider this proposition in greater detail. First, it is necessary to note that all six variables are updated frequently by various routines: the power ratio motivations by KULTUR, desired land fraction by DMFILE and ACBARG, etc.

Breaking down the equation into its parts:

$$V_R'(BH) + V_R'(\sigma R)$$

and treating it by parts.

The first proposition is that all of the perceived variables are different from the real values. The difference comes from three sources:

(1) BIAS due to hostility between the perceiver and the perceived.

(2) STOCHASTIC DISTORTION

(3) STATIC BIAS -i.e., an inherent tendency to over - or under-estimate.

Dealing with bias first:

We note six variables or arrays of variables:

(1) Bloc leader budget bargaining array of opposing bloc leader.

(2) Power ratio motivations of opposing bloc leader.

(3) Counter-force utility of the military forces of a conflict region opponent.

(4) The fraction of the conflict region each LCR opponent desires to own.

(5) LCR opponent MIL OPS against perceiver.

(6) LCR opponent verbal threat against perceiver.

The difference between perceived and real quantities due to bias (i.e., accountable rather than random distortion) is of the following order, even when there is no hostility (to be defined below). Corresponding to the numbers of the variables above,

(1) perceived = 1.01 real   (4) perceived = 1.03 real

(2) perceived = 1.03 real   (5) perceived = 1.02 real

(3) perceived = 1.01 real   (6) perceived = (1/1.03) real

This bias, as TEMPER calls ..., increases with hostility. The STATIC BIAS coefficient (i.e., 1.01, 1.03 ... 1/1.03) is raised to a power between 0 and 10.

Two separate values of hostility (HOSTIL) are calculated. One is used for the perception of bloc leader bargaining array and power ratio motivations, and is used by the bloc leaders. The second is used by all nation-groups for the calculation of perceived XCFUZ, ZDLND, ZDOMZ, and ZPSYZ.

It should be noted that HOSTIL really doesn't have too much to do with hostility. Several inadequacies exist in this exponent and shall be treated as necessary.

For the bloc leader perceptions (1) and (2) HOSTIL is:

$$\text{HOSTIL} = \text{STRTHT} * \left(\frac{\text{political alignment gains of the opposing bloc}}{\text{political alignment gains fo own bloc}} \right)$$

STRTHT is strategic threat to the bloc leader, without the credibility parameter, XCRED, included.

No indication is given of what period is included in summing the alignment gains. Only increases are included (i.e., the exponent cannot be negative). We might call it "inscrutable variable." Why decreases are ignored is a mystery; and, ignoring them is subject to the same criticisms as ignoring increases was in Influence Threat above. Why increases in alignment awards to the whole bloc are used is likewise unclear, for most of the bloc members could hate the leader. The parameter, furthermore, does not represent anything that one would normally label hostility. What it does represent is not clear.

The reason for this ratio according to TEMPER (II-42) is to give an indication of how well the cold war is going, and to use this to modify STRTHT.

(1) An indication of how well the cold war is going should include the losses as well as the gains.

(2) As this ratio times STRTHT composes HOSTIL for the bloc-leader perceptions, it is very important. Large values of HOSTIL can result in bias for power ratio motivations of as large a factor of 4/3. HOSTIL has a maximum of 10, at which this 4/3 bias is reached. As HOSTIL is totally insensitive to absolute magnitudes of alignment value change, it is possible that very small gains can produce very large ratios and thus the maximum bias factor. It is therefore suggested that the ratio be changed to a form such as $1 + \dfrac{\frac{(A-B)}{(A+B)}}{2}$ and scaled from 0 to 10; not

$\dfrac{\text{SUM(LL)}}{\text{SUM (L)}}$ see (IV-61) but rather $\text{MIN}\left(10, 5 \left(1 + \dfrac{\text{SUM (LL)} - \text{SUM (L)}}{\text{SUM(LL)} + \text{SUM (L)}} \right) \right)$

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This equation bounds the ratio at a maximum of 10, and eliminates the negative values inherent in the $\frac{A-B}{A+B}$ form.

Using this equation, and realizing that STRTHT varies from 0 to 1, HOSTIL must now vary from 0 to 10, as it presently does in TEMPER (see LISTING). The non-linear characteristics of this equation have not been considered and neither has the distribution. But it cannot be a worse equation than the one presently used for HOSTIL.

It should also be noted that this HOSTIL in its present form may be less than 1, and in that case the bias is less than the static bias (of 1.01, 1.03, ... 1/1.03).

Thus if the alignment value changes are favorable and STRTHT is low, then it is possible to perceive values of (1) and (2) almost exactly, if stochastic distortion is also negligible.

Whether this possibility of lo⁄ bias is intentional is questionable. A bias of less than the static bias is very possible, and can occur even when alignment value changes are unfavorable, for to make HOSTIL greater than one, the ratio of alignment value increases must be greater than $\frac{1}{STRTHT}$.

Fortunately, the ratio necessary to make HOSTIL = 1 decreases with increasing STRTHT.

But the following situation could occur, as the equations are now stated:

for bloc =L the target

    bloc =LL the initiator

if bloc L expects to lose 40% of its population in a strategic exchange, and bloc LL only 20%, when LL pre-empts; and if the maximum perceived MIL-OPS level is 7.1, convential war, (III-359) (6=KOREA WAR) then STRTHT = .2

Thus, alignment increases may be 5 to 1 against bloc L before it begins to bias its perceptions by more than a factor of 1.01 for (1), or 1.03 for (2).

This is not a reasonable result.

Thus the proposition that the accountable, as opposed to stochastic, component of the difference between the perceived and real values of (1) and (2) takes the form of a constant of 1.01 or 1.03 raised to the power HOSTIL which multiplies the real value to get the perceived value is unacceptable. HOSTIL in fact is an uninterpretable quantity, and its chief effect is to insure that the bloc leader bargaining array and the power ratio motivations are accurately perceived.

This part of the PERCEP routine shows the danger of taking the TEMPER documentation at face value when it names a variable, and the even more serious mistakes in evaluation that can be made because mathematical relations are not investigated. The documentation contains errors, particularly volume II (TEMP, not STORE). Most mistakes can be caught. But, even with Vol. IV, one must go to the program listing, as we had to, in order to find that the HOSTIL just discussed had a maximum of 10.

More interesting things can be found in the listing, as we shall soon see. The error just discussed is perhaps not very important, for the result is that perceived and real values are probably usually close. Thus problems for bargaining are some-what reduced and there is effectively less happening. We doubt that the designers intended it thus, else there would be no need for going through these calculations at all and perceived could be set equal to real in almost all cases.

HOSTIL as used to calculate bias in XCFUZ, etc., is a different variable. It is a function of two terms:

(1) The fraction of the conflict region the opponent is perceived to desire, times the sum of these three quantities; his military coercion motivation, ZMILC; his propensity to tax, ZTAXS; his propensity to tax for defense, ZMILI, which is

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closely related to the fraction of the budget desired for defense.

(2) 5 times the tactical threat from the opponent

The form is: <u>Perceived desired land fraction</u> (A+ B+ C)

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+ 5 (TACTHT)

There are several things wrong. By using the old perceived desired land fraction, all new perceived values of the four variables that this value of HOSTIL is used in perceiving are dependent on the stochastic component of this desired land fraction. Thus stochastic elements enter into the supposedly deterministic part of the perception process. Further, because desired land fractions are in part determined by past history, HOSTIL becomes an artifact of the TEMPER map. We are not sure whether or not the aggregation process for desired land fraction is adequate. It may be, we do not know.

While it makes some sense to use ZMILC and ZMILI here, as a measure of an opponent's designs on you, and his inclination and ability to carry them out, it is not clear why the general propensity to tax (ZTAXS) is included. One objection to its inclusion is that <u>it causes BIAS to be larger when socialist nation-groups are perceived</u>, as their ZTAX is higher--in fact this is the best operational measures of a socialist regime. It is certainly doubtful that a nation-group of Britians should be the cause of greater hostility simply because it has socialized medicine--or Sweden <u>a fortiori</u>. The implied relationship between socialism and bias is dubious.

A check of the LISTING reveals that TACTHT is not used as given in the THREAT routine. The part of TACTHT that is a function of CFU ratios is manipulated.

If the relevant CFU ratio is greater than 1.5, it is changed to ratio/10; if it is between 3/2 and 2/3 it is set equal to zero; if it is less than 2/3, it is changed to ratio = ratio +<u> .1 </u>

ratio

It appears that the (RATIO + .1/RATIO) is a mistake, and should be (- .1/RATIO) as in THREAT. This would scale the ratio between -1 and +1 as is done in THREAT.

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This error--if it represents the model as of 1 Jan. 65--is minor as the CFU ratio is far weaker in TACTHT calculations than the XDOMPZ factor.

It should be noted the real CFU values are used in the recalculation of TACTHT for PERCEP, while a perceived value is used for opponent CFU in THREAT.

TACTHT is probably more important in HOSTIL than the rest of the equation.

HOSTIL, and therefore bias, increases with increased desired land fraction (perceived), with an increase in the sum of ZMILC, ZMILI, and ZTAXS, and increases with tactical threat. In other words bias increases with what the opponent would like to do, his propensity to do it, and his current activities in that direction. This is the H in B^{11} (REAL VALUE).

Bias increases during war time. As MIL-OPS go up, so will HOSTIL; as HOSTIL goes up, so will perceived MIL-OPS. It is possible that an unrealistic escalation in perception bias is generated.

The second part of the perception equation is the stochastic distortion. The distortion factor is the product of two terms:

A standard deviation

A stochastically generated multiplier

The standard deviation is set in a three-dimensional array.

(1) There are six perception dyads--West-East, East-Neutral, etc.

(2) There are three types of information, which have different standard deviations (S.D.).

(3) There are two types of information for perception--overt and covert. The stochastic distortion of overt information is larger than that of covert. Overt means obtained in a regular manner. Covert refers to information gained through espionage, etc. The lower S.D. that is used in the equation when it is covert information being perceived means that covert information is more reliable.

Note here that there is no difference between covert and overt information. The difference is in the S.D. used in the perception equation. Covert/overt differences will be discussed again.

The stochastic multiplier is a "normally distributed random number"; or an evenly distributed random number with its range mapped onto an approximately normal distribution. The bounds are ± 3.2, representing 3-sigma values. The stochastic multiplier represents random error of observation, which is considered normally distributed. We shall call the random number "R."

The "standard deviation" is multiplied by R to get the number of standard deviations away from the mean (real) value that distortion represents. Thus the general perception equation includes observer bias plus observation error.

Several propositions emerge from the setting of the standard deviations:

(1) Covert information is likely to be distorted less through observation error. It is, however, just as subject to bias. Were it not that bias always has only one direction,* for each of the six types of variables observed, one could say that it is immaterial whether we talked about distortion or bias. Because the distributions of bias and distortion are different, and because distortion may raise or lower the value of a variable (bias either raises or lowers, depending on the variable), it becomes important to decide whether covert information is less subject to bias or less subject to "observation error."

We have mentioned that the S.D. 's vary according to the type of variable. The bloc leader bargaining array has the smallest S.D.--between .02 and .04 depending on the dyad types, for overt information; and between .01 and .03 for covert. It is not clear why volume IV gives S.D.'s for all the dyads for XBARPZ, since

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*You always BIAS an observation either higher or lower, depending on the type of information--while distortion is normally distributed (roughly) about the real value.

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only the two bloc leaders use this variable. Nowhere in either Vol. II or Vol. IV is it mentioned which class of information CFU fits. It may be here, but we do not know, and have not been able to follow through the listing to find out.

Let us rank order the S.D.'s--: The smallest is .01, for information of Type 1 and Type 2--Bloc leader bargain array and MIL OPS level--covert information; and for an Eastern Bloc (E) member perceiving a neutral (N). The highest is .06 for Type 3, overt, E-W or East perceiving West.(IV-75)

Rank order of standard deviations according to mode of reception

High : Overt
Low : Covert

Based on average of all 3 types of information, rank order of standard deviations to dyads (perceiver first)

	Overt	Covert
SD high	N--W	N--W
	E--W	W--N, W--E
	W--E, W--N	E--W
	N--E	N--E
SD low	E--N	E--N

Rank order of standard deviations according to type of information--

SD high	Psych. Ops
	Desired land Fraction
	Power ratio Motivations
	Mil Ops
SD low	Bargaining Array

It is possible to rank order according to all three of the classifications, giving a list of 36 (there would be less because of ties). Rather than this, see (IV--75).

Propositions such as the following can be stated:

Eastern bloc perceptions of neutrals will have the smallest average error of observation for both covert and overt information.

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Neutral perceptions of the West will have the largest observation error, both for covert and for overt information.

Eastern bloc perceptions of neutrals have less observational error than Eastern bloc perceptions of the West for both overt and covert information. Neutral perceptions of Eastern bloc nation-groups are among the most accurate. Their perceptions of the West are the least accurate, in terms of observation error.

Several things bear noting. The error of observation is a handy way of getting at things. What goes into the distortion of information we do not know; but, it can probably be handled more systematically than this. There perhaps is no need for that, however.

It is not clear how important the whole perception process is, and whether this stochastic routine adds anything at all. The maximum stochastic distortion is ± .06 x 3.2, or ± .192. This is a large swing--a factor of almost 40%. Its influence is not clear.

Several more propositions are asserted here.

(1) Covert information is treated as more reliable. When perception of "covert" information is performed, the new perceived value replaces the old one. When perception of "overt" information is performed (remember, the difference is in the S.D. only), the new perceived value is averaged with the old perceived value, and this average value is used.

There is a time schedule for perceptions. New information may be received only at certain intervals.

	Overt	Covert
(1)	every 12 weeks	every 24 weeks
(2)	4	12
(3)	4	12
(4)	4	12
(5)	1	2
(6)	1	2

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If it is time for perceiving overt information, this is done.

If it is time to perceive covert information, a probabilistic check is made to see if the information is received. A random number is generated (between 0 and 1) and compared with a decimal to see if the covert information is received. The decimal varies with the type of information and the dyad.

If the interval is right, a country is most likely to receive information about the bargaining array ($P = .9$ to $.5$ depending on the dyad), next most likely about MIL OPS ($P = .3$ to $.8$), and least likely about power ratio motivations, desired land fractions, or verbal threat ($P = .03$ to $.06$). See (II-47) for the table of probability of transmission.

Consider the rank order according to dyads (average of all three types). There may be ties in the cells, but in no case will (i = type, j = dyad)

$$\text{if} \frac{\sum_i P_i, (j=a)}{3} > \frac{\sum_i P_i, (j=b)}{3} \qquad P_{(i=n), (j=a)} < P_{(i=n), (j=b)}$$

Rank Order

    Prob. of transmission = high   N--W
                                       E--N, W---N
                                       E--W
                                       N--E
                                       W--E

Thus a Western bloc N.G. is least likely to receive covert information about an Eastern N.G. if the interval is right.

Covert information is most probably received for a Neutral perceiving the West.

The Eastern block is more likely to receive covert information about the West than vice versa--

And both East and West are equally likely to receive covert information about a neutral.

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Neutrals are more likely to receive covert information about the West than about the East.

Eastern N.G.'s are least open to giving up covert information. The West and the Neutrals are about equally open, but the West is more open to the Neutrals than neutrals are to either E. or W., and is less open to the East than the Neutrals are to E. or W.

The setting of these probabilities of transmission should be empirical, but the overall effect of these probabilities is dependent on the transmission intervals given above.

A few noteworthy calculations: there is a 12-1/2% chance that no new covert information would be perceived about the East's bloc leader bargaining array by the West for 2 years. There is a 24% chance of the West not receiving new covert information about the East's power ratio motivations for a year and a quarter.

It would seem that the West has a very poor intelligence system.

Thus: A nation group is more likely to receive overt information than covert. It is more likely to receive some kinds of information than others.

Average covert transmission rates can be calculated. The formula is

$$\sum_{i=0}^{i=n} P (1 - P)^i \qquad \text{where the P is probability and the n represents the number of quarter-year intervals, i.}$$

Thus, for a given P and a desired level of transmission, we can determine the n. For example, if P = .4 and we want the above formula to be at least .9 (transmission assured 90% of the time), the value of n will be 5 intervals, or one year and a quarter. Similarly, if one were satisfied with an average of 50%, a P = .5 would require one interval, and a P = .3 would require 2 intervals. Most P of transmission are greater than .5, and it would therefore require three intervals

or 3/4 of a year for a transmission rate of at least 90% (more exactly, .936).

Thus one can see that there might be some long information droughts.

For a western bloc member receiving covert information about an Eastern bloc member's desired land fraction, where $P = .3$, you need 7 intervals, or a year and three quarters to ensure a 90% chance of receiving covert information.

These probabilities should be investigated. Perhaps the array that holds them, PSTRAN (IAMB, ND)(see II-47) can be eliminated. The probability check appears to be an unnecessary frill.

It is perhaps useful to have differences in the rate of reception of covert information across dyads, but why not handle this by establishing an array of covert information transmission intervals?

Variables	W perceiver E perceived	E N	N W	W N	E W	N E
(1)	36 weeks	24				
(2) (3) (4)	24	10		etc.		
(5) (6)	4	3				

A few more suggestions:

The distinction between covert and overt may make only limited sense for MIL-OPS levels, particularly for a MIL-OPS level of 3 (minor guerilla war) and up. Planned MIL-OPS would be something else, but here we are dealing with actual, present MIL-OPS. The distinction makes less sense for psychological operations—ZPSYZ. Eliminating it would save core space.

It is unclear what the effect of perceived rather than real values is on a nation-group's actions, for it is unclear what the average difference is between real and perceived values. This average difference is a function of bias only, as distortion is symmetrical around the real value.

The whole distortion part of perception is potentially unnecessary, partly because there is no indication given of what might give rise to this stochastic error.

The magnitude of stochastic error should be considered. About 2/3 of the time it will be $\pm\sigma$ (real value) but 1/3 of the time it will be greater, which can mean an error of $\pm$ 6%, for some covert perceptions. There is a .032 chance that a neutral's perception of a Western Bloc N.G's MIL-OPS against it may change by a factor of 12% or more over a two week period, for example.

The justification for having some variables more accurately perceived than others, and the magnitude of this difference, need be considered.

The hostility exponent (H in B^H) for bloc leader perceptions has been questioned earlier. "Hostility" for LCR perceptions should be investigated for its likely range.

(1) Assume that a N.G. will on the average be perceived to desire 40% of an LCR--slightly more than 1/3--

(2) 7 is a reasonable value for ZMILC--see Vol. VII

(3) 2 is not an unreasonable value for 10 times the % of the government budget for defense.

(4) 3 is not unreasonable for (% of GNP taxed)x 10.

(5) 2.5 is an average TACTHT x 5, (TACTHT from 0 to 1).

With these values, HOSTIL = 4.1. This may be rather strong bias for a not very serious situation.

R = an approximately normally distributed random number between -3.2 and + 3.2

σ = standard deviation for observation error of a real value from .02 to .06.

B = static bias--from 1/1.03 to 1.03

H = "Hostility"--from 0 to 10

Perceived value = $(B^H + \sigma R)$ (real value)--for covert information

Perceived value = $\dfrac{(B^H + \sigma R)\ \text{(real value)} + \text{old perceived value}}{2}$

for overt information.

Above are the two equations that summarize the perception process.

KULTUR

The KULTUR routine sets and updates motivations. There are six motivations which help determine the behavior of a nation. We have come upon some of them already.

(1) ZEXTD: "External dynamism, intensity of concern with and pursuit of an international following. For neutrals, a measure of a desire for independence". It is used as a factor in assigning alignment points and ally value because of trade or aid. It is used for neutrals in political threat. In fact, it is basically a measure of the willingness or resistance to assign ally or alignment value. It is initially set in the data base by the user as an estimated value.

(2) ZINTI: "Investment motivation" is initialized as the annual rate of economic growth. It is used in some economic calculations.

(3) ZMILC: Propensity to use military coercion, is set in the date base by subjective evaluation--i.e., it is soft. Used in escalation, bargaining, and in PERCEP, above.

(4) ZMILI: "Military" initiative = 10 times the fraction of government expenditure going for defense. Used in budget and problem recognition calculations.

(5) ZTAXS: Propensity to tax, equals, initially, the ratio of government expenditure to GNP. It is used in economic routines, problem recognition, and perception.

(6) XMPWRZ: power ratio motivations, exist for bloc members only, and are initially set at the 1960 ratios of one's own bloc leader's expenditure to the opposing bloc leader's expenditure for:

R and D.

strategic forces expenditures -- O & M and procurement

O & M costs of tactical forces.

The bloc leaders are the U.S. and the U.S.S.R. in TEMPER.

In bargaining and problem recognition, as well as being perceived above, the power ratio motivation of bloc members (XMPWRZ) is used.

XMPWRZ is not calculated for neutrals.

Disregarding how these motivations are initially set, for this is not a part of KULTUR; and further disregarding how they are updated on day zero--it is not really of interest, the difference between day zero and any other time is simply the absence of political threat--we can discuss how these motivations are updated.

In other words we are interested in how these motivations change.

There are three strategies for change.

(1) is for the power ratio motivations

(2) is for "External Dynamism"

(3) is for ZINTI, ZTAXS, ZMILI, and ZMILC.

(1) Changes in power ratio motivations are a function of threat alone. Set into the date base are maximum and minimum values for power ratio motivations for each bloc. It is of interest what these values are, for propositions are contained therein. The maximum and minimum values correspond to no threat and total threat conditions.

For the U.S.:	No Threat	Total Threat
desired R and D spending ratio	2.15	1.75
desired ratio of strategic O and M costs	3.01	2.4
desired ratio of tactical O and M costs	1.806	1.44

For the U.S.S.R.:		
desired R and D spending ratio	.464	.37
desired ratio of strategic O and M Costs	.332	.27
desired ratio of tactical O and M Costs	.554	.444

One can see from this figure that the maximum decrease in power ratio motivation is about 20%.

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Further, the U.S. desires a marked superiority to the U.S.S.R. while the U.S.S.R. is rather content with adverse power ratios. The U.S. and the U.S.S.R. ratios are approximately reciprocals.

Once power ratio motivations are set on day zero, they are updated quarterly, according to the following formula--

(Remember that Threat is

2/3 military threat + 1/3 political threat)

New PRM = MAX + (MIN-MAX) THREAT

where MAX = no threat value

MIN = total threat value

THREAT varies from 0 to 1. Noting that the no threat value is the higher of the two, one can see that PRM's are a decreasing linear function of threat in the form of $y = mx + b$. The slope of the line is the difference between no threat and total threat values, and is negative in all cases.

A power ratio motivation is thus a function of THREAT, and also of whatever considerations have led to the setting of the limits. It is not clear how these limits are set, but they appear to be related to actual U.S. and Soviet values.

Another proposition is that the change in power ratio motivation may be no more than about a 20% decrease in the no-threat value.

One should keep in mind the complex calculations that go into THREAT. See above.

All bloc members use the bloc leader's PRM's.

Whereas Vol. II argues that Soviet PRM's are less sensitive to threat than U.S. PRM's, this is not the way it is programmed, as the proportional changes in either are about the same; this can be seen from the above discussion.

(2) ZEXTD:

On day zero ZEXTD, "external dynamism," is aggregated from national values for the nation-groups.

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ZEXTD is then multiplied by $(1 - \text{military threat})$ for day zero, and bounded between .01 and 1.0.

It is not clear whether more calculations are done on day zero but it appears so, from both the listing and the flow chart in VOL. IV. If this is so (and a similar double operation would hold for all motivations except the PRM's), then the double calculation of motivations is unnecessary.

Updating ZEXTD is done by the following equation:

$$\text{ZEXTD} = \text{ZEXTD} (1 - \text{Mil. Threat} + \text{Pol. Threat})$$

Therefore, external dynamism is a function of itself, and the two kinds of threat. If political threat is the larger of the two, ZEXTD increases. If mil. threat is larger, then ZEXTD decreases. Restating the equation clarifies this.

$$\text{ZEXTD} = \text{ZEXTD} + (\text{Pol. Threat} - \text{Mil. Threat})\ \text{ZEXTD}.$$

A fraction of the old value is added to or subtracted from old value in order to get the new value. The magnitude of the fraction is a function of the difference between political and military threat.

It would seem that given the meaning attached by the designers to ZEXTD, this is a rather simple updating procedure. One must judge by the way it is used.

In awarding ally or alignment value for offers of military aid, values of ZEXTD are inversely related to the points awarded. Points $= F \left(\frac{1}{(\text{ZEXTD})} \right)$. As low values of ZEXTD are associated with high values of military threat in comparison with political threat, one must consider the definition of these types of threat.

(1) It is not at all obvious that relative, rather than absolute, magnitudes are here what is important, given this use of the variable ZEXTD.

(2) It is likewise not clear why political threat should be so important. Remembering that it is a function of TACTHT to N.G.'s which one has awarded ally value to, and of negative alignment point changes, why is it relevant for the

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purpose of awarding ally value to N.G.'s which offer military aid?

Yet, the updating procedure does seem acceptable given the concept ZEXTD is supposed to represent, and does seem reasonable for use in PERCEP.

One cannot evaluate a variable such as ZEXTD on its definition, but only through examining the use to which it is put.

(3) It should further be noted that ZEXTD is very much dependent on its past history, as well as present threat levels. This gives the variable a resistance to very recent threat levels, and creates a "history" that may be important for the use of ZEXTD in WINECO and WINOVR. To fully evaluate these propositions it is necessary to have some understanding of how rapidly ZEXTD is likely to change, for only in this way can one discover to what extent the "history" of ZEXTD operates. An examination of simulate data is ultimately necessary.

(3) ZMILC, ZMILI, ZTAXS, ZINTI.

We mentioned at the beginning of the discussion of KULTUR the simple definitions of two of these motivations. The two are subjective. After aggregation, day zero functions are performed.

On day zero, a NO-THREAT value for these four motivations is established on the basis of: THREAT, which at this time is military threat only, the value of these four motivations that results from aggregation; and a maximum threat value (same for all nation-groups) set into the data base.

Threat, it should be remembered, is 1/3 political threat and 2/3 military threat, so that the day zero value of THREAT is 2/3 military threat.

The NO-THREAT value is set by the following equation:

$$\frac{(\text{Aggregate motivation value}) - \text{Max. Threat Value} \times \text{Threat})}{(1 - \text{Threat})}$$

The maximum threat values are:

ZINTI	0.0
ZMILC	10.0
ZMILI	8.0
ZTAXS	0.7

TEMPER proposes that internal investment for economic growth decreases with increasing threat. The other motivations increase with threat.

It is indicated in the numerical example of KULTUR (IV-88ff) that day zero THREAT will be rather low, and thus that the overall effect of this NO THREAT value equation is to set the NO THREAT value slightly below the day zero value of the motivations for each N.G. (slightly higher for ZINTI). The higher the day zero THREAT, the lower the NO THREAT value, except for ZINTI.

It is not clear why this is done. If it is done, as seems likely, because the data-base values used to compute the original values of ZINTI, ZMILI, etc. are assumed to represent some threat—i.e., setting ZMILI as the ratio of military to government spending in 1960 reflects 1960 threat levels, then this calculation is entirely justified.

Once the NO-THREAT value has been established, one can then update the motivations.

This is done in a familiar manner:

NEW VALUE = NO THREAT VALUE +

(TOTAL THREAT VALUE - NO THREAT VALUE) THREAT

Thus, unlike external dynamism there is no history here. These values are a function of things other than threat only in the sense that the NO-THREAT value reflects the DATA-BASE aggregation. Change in ZMILC, ZMILI, ZINTI, ZTAXS are a function of THREAT alone.

Magnitudes are function of THREAT and of the day zero calculation just reported.

ECON

PDCNTL

In the economic model we shall comment on propositions that are of political relevance.

In PDCNTL, mostly simple calculations from DATA BASE variables are done for definition.

There are few things political here. One of them is

(1) Capital Wealth is a weak function of threat in the following manner.

$$\text{CAPITAL WEALTH} = \text{CAPITAL WEALTH INDEX} \left(\text{GNP}_{\text{Quarterly}} \right)$$

$$\text{CAPITAL WEALTH INDEX} = 3.7 + \frac{1}{2} \left(\frac{\text{NO THREAT ZINTI} - \text{ZINTI}}{\text{TOTAL THREAT ZINTI} - \text{NO THREAT ZINTI}} \right)$$

Remember that TOTAL THREAT ZINTI = 0 and one may recognize that the denominator must be negative. The numerator is positive. The larger THREAT is, the smaller (more negative) this fraction becomes. At maximum THREAT, CAPITAL WEALTH becomes 3.2 GNP, at NO THREAT it is 3.7 GNP, and thus CAPITAL WEALTH is a linear function of ZINTI, and thus of THREAT. We cannot evaluate this proposition without referring to the uses of CAPITAL WEALTH (XCAPCL,J) and this would take us far into economics. Indirectly, capital wealth is a function of opponent military operations levels.

A capital consumption or depreciation index is a linear function of ZINTI also, and thus of THREAT.

Capital depreciation increases linearly with threat.

CONTRA:

"A nation will first use opportunities to export to regain declining friendship and then will import to satisfy internal demand." (II-72).

This subroutine and that which follows it (TRADING, cf II-77) probably exaggerate the extent to which trade is used as an instrument of foreign policy. The rules of these two subroutinues may constitute prescriptive norms for Realpolitik trading, but they are too calculated to represent the manner in which governments actually behave. Centralized regimes with monopolies over foreign trade may of course carry on their business with less regard for domestic factors (including profit)

than capitalist governments.

Trade is conducted quarterly. The routines for the conduct of international trade may be retained if it is decided that the effect of trade on ally and alignment values is unimportant for the model. However, we strongly doubt that the decision routines for trade bear any resemblance to real-world decision rules. These decision rules have a harmful effect on ally and alignment values, and thus on every political part of the model.

To begin with, see II-75. There it is related that there can be no trade between neutrals, no trade between WEST and EAST bloc members. Neutrals may import from bloc members, but only in political trade--i.e., by decreasing the alignment points awarded to a bloc member--and may export to bloc members only for "residual" trade--i.e., when they have awarded a high alignment value to a bloc member. Thus stringent political restraints are placed on trade.

Further, note here that there is no such thing as economic aid. In TEMPER, the trade routines must serve both trade and aid; it is therefore nearly impossible to evaluate the equations and decision routines, for they aggregate two very different phenomena.

A further and more reasonable stricture is that of the six sectors of the economy:

        (1) military
        (2) light industry
        (3) heavy industry
        (4) agriculture
        (5) mining
        (6) services

The first and last sectors are considered unexportable, so trade can only take place in the middle 4.

The decision routines for trade have four parts:

(1) the sequencing of dyads

(2) the testing of dyads for matching surplus and demand in sectors

(3) the decision of how much to trade once surplus/demand matches have been identified.

(4) the increases in ally or alignment value that result from a successful transaction.

A transaction consists of one country exporting from a sector and another importing. It does not consist of an exchange, i.e., country A imports in sector N, and exports from sector M to country B.

There are two kinds of trade:

        Political   Residual

Political trade involves the exporting of goods to an N.G. which has decreased the ally or alignment points awarded to the exporting nation. An N.G. can successfully decrease the ally or alignment points it awards if it has no demand in the four sectors where trade is allowed. If it has demands, and decreases its awards, the object of these awards will seek to fulfill the demands and thus force the N.G. to award ally or alignment value, as a function of ZEXTD of the awarding N.G.

Changes in ally/alignment value are wiped out at the beginning of WINECO. Therefore, the increases or decreases computed in WINECO are the first of the changes that are accumulated over the quarter for use in CONTRA and TRADER for political and residual trade.

One must consider why an N.G. would decrease its awards of ally/alignment value, and whether this is an adequate stimulator of a desire to fulfill demand on the part of the object N.G.

We shall discuss the steps in the decision routine for political trade first. It should always be kept in mind that the validity of propositions depends on

        (1) how the variables are to be used

        (2) the validity of the relationship established, without regard to

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alternative ways that trade may be conducted--i.e., is this a way to

conduct trade?

(3) the fact that this is one of only two ways that trade may be conducted.

For political trade, CONTRA compiles a list of up to 40 N.G. pairs, or dyads,

on the basis of the largest declines in ally or alignment points.* At the top of

the list is the N.G. which has withdrawn the largest magnitude of ally/alignment

points from another single N.G., and the object of this withdrawal of friendship.

The next dyad is made up of the two N.G.'s involved in the second largest withdrawal

of friendship; etc., down to the 40th largest. An N.G. can appea: on the list

several times, and one must, as the list has 40 items, and there are only 39 N.G.'s.

CONTRA then scans the sectors where trade is allowed in the N.G. which with-

drew friendship to see if it has unsatisfied deman.! in any sector. It then scans

the sectors of the N.G. which has suffered the loss of friendship, and sees if that

N.G. has a surplus it can use to fill the other N.G.'s demand. If so, it exports

in an attempt to recover some of the friendship value (ally or alignment value).

Political trade, one of two kinds, is conducted according to three decision

rules:

The first criterion for political trade is a decline in the ally or alignment

value the importer awards to the exporter.

The second criterion is that opportunities to export are given according to the

largest declines in ally/alignment value (A/A) suffered in a dyadic relationship;

and that opportunities to import are given according to the magnitude of retraction

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*Since WINECO was last called--that is, in the previous quarter, after all trade
had been conducted. Decreases may arise because of the magnitude of trade in the
dyad in the previous quarter, as well as from MIL AID, from threat in the LCR
to a neutral, and from decreases figured in DMFILE.

of ally/alignment value in a dyad, largest first, in rank order.

The third criterion for political trade is that the N.G. that has lost A/A value have a surplus in a sector in which the retractor of A/A value has excess demand.

A few more rules:

(4) In political trade, the supplier fills as much of the importer's demand as he can. This may be all of it in all four sectors, precluding the possibility of the importer being supplied from another N.G.

(5) The supplier must export all of his surplus if the importer can take it. He may thus be precluded from winning back alliance points that have been lost elsewhere.

(6) The importer must pay for the trade whether he can or not, given his balance of payments situation. This is trade: money for goods. It is not economic aid.

All four sectors are scanned, the maximum possible trade (on a book-keeping standard only) is conducted in all four sectors, and is summed. The amount of trade conducted between this dyad is stored for this dyad for use in WINECO.

It is not clear if trade (TRAD (NUM)) for WINECO consists only of imports, or of exports also. From the numerical example, it appears that only imports count, for (TRAD (NUM)) is for N.G.$_A$ exporting to N.G.$_B$, and we know that it is the importing N.G. that awards points for political trade. So, it must be the same here; and we conclude that for the purposes of WINECO--awarding A/A value--only imports count. N.G.$_A$ awards A/A value on the basis of what it has imported from N.G.$_B$. Exports from N.G.$_A$ to N.G.$_B$ are irrelevant for N.G.$_A$,s awards of A/A value.

We have so far discussed how political trade is conducted, and a series of decision rules have been clarified. The result of Political Trade is a value (TRAD (NUM)) which records how much an N.G. has imported, in order to use (TRAD (NUM)) in WINECO.

Residual Trade is conducted on the basis of demands and surpluses, modified by friendship value. Sector demands (not N.C. demands in all four sectors, but only in one) are ordered. The largest (sector demand) /GNP is considered first. Potential suppliers are located, and they all donate a fraction of their supply toward the demand based on how much they have to supply, and how friendly the suppliers are toward the importer.

The following decision rules are established. They should be considered with reference to the three criteria suggested above.

(1) A nation will not import unless it has demand in a sector that it cannot satisfy internally.

(2) The second criterion for residual is that sector demands to GNP ratios are considered, not N.G. total demand in the four sectors, where trade is allowed for priority.

(3) These sector demands are divided by the N.G.'s GNP and rank ordered until the (sector demand) /GNP no longer exceeds a threshold. We do not know its value, but assume it is reasonably small.

(4) The (sector demand)/GNP ratios are considered in order from the largest to the smallest.

Among the propositions that may be restated here is that nation groups with the most pressing demands in a sector are satisfied first. This may preclude the satisfaction of less pressing demands in the same sector elsewhere because of exhaustion of supply. This point will be clearer when we discuss how demand is fulfilled.

It should be noted that satisfaction of demands is not biased toward wealthy N.G.'s; and it is likewise not biased toward large sectors.

The latter is true because although demands in large sectors are likely to be a higher fraction of GNP, and are thus handled first, the fulfilling of these demands does **not** affect the fulfillment of demands in smaller sectors, for it does not affect the supply for these small-sector demands.

Demands for residual trade are fulfilled in the following manner.

As shown above, residual trade in one sector has no effect on residual trade in another sector. It is therefore convenient here to consider sectors as being treated one at a time. We shall use the term "most urgent demand" to refer to the largest demand/GNP in a given sector. This will make the discussion clearer for the purposes of propositions to come.

(5) Considering any given sector, the most urgent demand is treated first, the next most urgent second, etc.

(6) Potential suppliers are considered on the basis of A/A value awarded to the N.G. with demand. Supply from the most friendly N.G. is determined first, and this amount supplied affects in turn how much will be supplied by the next most friendly N.G., and the third most, etc.

Because of the mathematical complexity generated by this "chain rule," propositional statements with regard to the amount supplied by each potential supplier are difficult.

Because a nation group **must** have awarded A/A value to the demander in order to be a potential supplier, it is **impossible** for a neutral to fulfill demand through residual trade.

This is a conclusion on our part, and is not explicit in the TEMPER documentation. The opposite is suggested on page 130 of Vol. IV.

"If the demand Nation-Group is a Neutral, it scans the alignment value, ZFPAP (NPAP) list." The chart on page 75, Vol. II supports our interpretation, however,

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as does the rest of the discussion of TRADER in Vol. IV.

A neutral, then, may satisfy demand only if it has withdrawn alignment value from a bloc member that has a surplus in the sectors it has a demand in, and only if the alignment value it withdraws is large enough to place this dyad on the "top 40" of A/A value decreases. This is, of course, absurd, and vitiates WINECO for neutrals, however valid WINECO is without considering the inputs to it.

We may continue now the discussion of how transactions are computed for "residual" trade.

The supply accepted from the most friendly N.G. is computed in the following equation:

Supply from most friendly N.G. =

$$\frac{(DEMAND) \times (SURPLUS \text{ in the DEMAND SECTOR}) \times (A/A \text{ VALUE})}{\sum_{\substack{ALL \text{ N.G.'s AWARDING} \\ IMPORTER \text{ A/A VALUE}}} (SURPLUS) \times (A/A \text{ VALUE})}$$

Whether demands are fulfilled is not a function of how friendly your friends are. It is a function of whether your friends, however weak, have a surplus you need. How much they supply is a function of how friendly they are relative to your other friends, and of their surpluses.

Surplus is the supply N.G.'s inventory in that sector.

The summation is limited to 12 nation groups. We assume this to be the 12 most friendly, but the documentation does not say.

This equation gives a fraction of the importing N.G.'s demand that may be supplied by the supplier being considered. If this fraction of the demand is larger than the surplus of the potential supplier, the supplier sells his whole inventory.

The amount accepted from the most friendly supplier is then subtracted from the demand and the above equation is then applied to the next most friendly potential supplier. This time, of course, the first supplier is not considered in the

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denominator. This process continues until all potential suppliers have been con-
sidered, and their supply determined.

Despite the complexity generated by this "chain rule," some statements can
be made.

First, all possible suppliers will supply some fraction of their surplus, to
the N.G. with the most urgent demand (in a given sector). Second, some suppliers
may not be around to satisfy the second most urgent demand in a given sector.
Third, the most urgent demand may take all possible supply, leaving nothing for
less urgent demands.

This third point causes us to question the "residual" trade routine because:
in WINECO, A/A value is awarded or retracted on the basis not of imports in a dyad,
but of the difference between imports this quarter and imports last quarter. This
residual trade routine is obviously artificial. Trade is conducted on the basis
of who can pay, and not who needs it, and supplies are determined only partly by
friendship. The process as programmed fails to take account of the theory of
"comparative advantage" in calculating trade. Because the artificialities may cause
a decline in trade compared to the previous quarter, and thus cause a decline in
A/A value an importer awards to a potential supplier, one must conclude that the
residual trade routine as a whole can introduce unreasonable changes in A/A value.

While a number of things are unsatisfactory in the trade routines, propositions
are difficult to state, as functional relationships are few, simple, and embedded
in sequencing rules. It is perhaps possible to phrase a proposition awkwardly:

"A neutral N.G. that has unsatisfied demands in its economy will have them
satisfied by the N.G. it withdraws the most alignment value from first, if the
object of the reward withdrawals has surplus in appropriate sectors, and if it has
not given away its surplus to another N.G., from either bloc or a neutral, that

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withdrew more A/A value."

Such a trade routine in CONTRA and TRADER ignores or violates established propositions regarding international trade, in both its political or economic aspects. There are undoubtedly political rules governing international trade that are quite different from the purely economic ones, but they probably are not the ones stated here.

In these routines there is no allowance for comparative advantage, no consideration of tariff structure, no conscious exporting (except for politically motivated trade) no conscious triangular trade.

No attempt is made to balance payments, though this is considered later and influences trade through its influence on sector demands.

In political trade, nation-groups are forced to satisfy their demands by the criterion of whom they hate most this week, rather than whom they like most, or who offers the best price. We have noted above some unreasonable restrictions on trade--neutrals may export only to bloc members in residual trade, may import only from bloc members in political trade. Inter-bloc trading is impossible, yet Fiat of Italy is about to set up an auto plant in Russia for $3/4 billion, and England, France, and Germany trade with East Europe and even China.

Even in one grants these strictures on trade, the trade that results is conducted according to completely unrealistic decision rules and the resulting input into WINECO is therefore artificial.

WINECO itself is not an unreasonable routine, but the input to it makes it impossible for A/A value changes to be meaningful though they may be harmless if very small. If A/A changes are vitiated, then THREAT is vitiated, and correspondingly so are perceptions and motivations. Thus there are serious consequences for the entire model. Among the most important improvement would be corrections in CONTRA and TRADER.

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WINECO

Change in A/A value is caused by trade. We restrict the definition of dyad
here to mean only two nations that trade, with one of them being an importer only
and the other the exporter. There may be trade in the other direction but this
would require a different dyad. Dyad (AB) thus is different from dyad (BA). The
importer is important here.

WINECO checks dyads and compares the trade in them to the trade in the previous
quarter. Imports, as noted, are what count, and A/A value is awarded or retracted
on the basis of how much $N.G._A$ has imported from $N.G._B$. Imports by bloc members
from neutrals have no effect as bloc members award no points to neutrals. Thus
trade in this kind of dyad is not registered for the purpose of assigning A/A
value.

If an N.G.'s imports from another N.G. have increased relative to the previous
quarter, it raises the A/A value it awards the exporter. If imports have decreased
relative to the previous quarter, A/A value is reduced. If there is no change,
there is no change in A/A value.

$$T = DELTA \times \frac{(External\ Dynamism\ of\ Importer \times 10)}{(Quarterly\ GNP\ of\ Importer)}$$

then, change in A/A value

- = (1 - old A/A value) (tanh T), if DELTA > 0.0
- = (old A/A value) (tanh T), if DELTA < 0.0

Several propositions emerge:

Remember that this is only one way to change A/A value, and that these propo-
sitions refer to change in A/A value due to trade.

(1) The higher the external dynamism of the importer, the fewer A/A points he
will assign or withdraw for a given (change in imports)/GNP.

(2) The argument of the Tanh function should usually be small, making the
relationship roughly linear.

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(3) The higher the initial level of A/A value, the _less_ sensitive the importer will be to increased trade, and the _more_ sensitive he will be to decreased trade.

(4) The lower the old A/A value, the more the reverse of (3) holds.

(5) Nation-Groups will change their friendship towards an exporter on the basis of whether the exporter fills more or less of their needs than he did the previous quarter.

(6) Nation-Groups change their awards of A/A value only for changes in imports over the previous quarter. Changes in A/A value are independent of exports.

(7) Changes are inversely related to external dynamism and to GNP of the importer, and directly related to the magnitude of the change with relation to the previous quarters' imports in the dyad.

(8) Awards of A/A value in a dyad are independent of any other awards and of any other trade relationships: i.e., an N.G. does not have a limited amount of A/A points that he must ration to his suppliers.

It is not clear why exporters do not award A/A value to their markets. Certainly the U.S. does, and it is a historical fact that a nation sometimes will protect its best markets with military action.

It is not clear why an N.G. must slavishly award A/A value to an N.G. that has increased supplying it; and also why an N.G. must withdraw points from an N.G. that has decreased supplying it.

Because of this fact of the TEMPER world, an economically developing neutral that is approaching self-sufficiency must find itself awarding fewer and fewer alignment points, and thus finding it harder and harder to export, given the strictures of residual trade.

The only entirely satisfactory propositions here are (3) and (4), and then only as the specific functional relationship is a first approximation.

The concepts behind WINECO are too much like CONTRA and TRADER.

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FORMAP

FORMAP is a simple routine which we do not choose to evaluate, as it is basically a bookkeeping routine for military budgets. It is therefore economic. A check of the "Functions and Significant Variables" chart(IV-166) reveals that political variables influence FORMAP only indirectly, and that its outputs are essentially non-political. The decision routines are likewise non-political, and for the most part involve procurement as a function of budget constraints, with no particular attention paid to political aspects of budget variables.

One comment that may be made is that <u>neutrals</u> are not allowed to own shipping units. This is, of course, a simplification of the real world. No allowance is made for shipping war goods in foreign bottoms; there is at least the possible necessity of doing this.

There also seems to be an assumption that unit procurement costs for various types of forces are the same for all nation-groups. We are not sure that this is true; differences may be accounted for in the way certain data-base variables are aggregated.

WAR SUBMODEL

Most of the war submodel does not need evaluation. Wars are obviously not conducted in TEMPER in a way that remotely coincides with the ways in which war in the real world progresses. The actual advances and retreats, the population losses, work force decreases, casualties, force losses and such are for the most part artifically simulated.

There is, however, no particular reason for this situation to be any different. There was no attempt by the TEMPER designers to develop a model of the progress of wars. That would require specific location of forces and force types; decision rules for attacking and retreating; strategic and tactical plans, and such. Recognizing this, the TEMPER designers created an artificial war routine that produces plausible advances and losses of various kinds. What they were interested in were plausible inputs to military aid, escalation, and bookkeeping decision routines.

As such, the propositions are for the most part artificial and it is not necessary to evaluate the internal realism of them. We therefore pass over LIWAR, FIGHT STAGER, and NAVFYT. NAVLOG is also of little relevance here. It assigns naval forces to various sea conflict regions on the basis of where the land conflict is. It makes little difference how these forces are assigned, as there is a wide latitutde for any decision which can reflect different conceptions of where threat lies, and such matters within the government.

Propositions relevant for political matters are found in SHIFT and REMOVE.

There are, however, occasional things of political relevance in the five subroutines that are mentioned above.

(1) In LIWAR, a check is instituted to see if the MIL OPS level of any N.G. against another N.G. in the conflict region is 6 or greater. This means local conventional war. Local conventional war is always recognized (XPERCE) and responded to in kind.

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Describing STAGER in Vol. II(P. 110) the documentation states that "When an incoming entry for exogenous force (mil. aid) is less than five per cent of the total of that type force in the Nation-group, then it is accepted as a gift and added to indigenous forces. If an exogenous force is withdrawn and results in an exogenous force of less than five per cent of total force for the type involved to the Nation-Group deployed by the owner, then the remaining exogenous forces for that entry and the corresponding utility points are transferred to the ownership of the Nation-Group where they are located." The same seems to hold if the exogenous forces of a given type are reduced to less than 5% of that type through attrition in war.

It appears then that whenever military aid of a given type, or the force level of exogenous forces of a given type donated by a particular nation-group, is less than 5% of the total of that type of force in the Nation-Group, it is treated as if it belonged to the Nation-Group where it is located.

SHIFT and REMOVE

It is impossible, unfortunately, to consider the five subroutines, SHIFT, REMOVE, LIANCE, XLIANCE, and WINOVR, separately.

SHIFT calculates desires for military aid, and on the basis of offers computed in REMOVE, selects aid from available sources.

REMOVE prepares a table of aid available for shipment to needy nations on the basis of a willingness to aid computed in XLIANCE and WINOVR.

LIANCE calculates force needs also, adding to or subtracting from the value computed in SHIFT.

XLIANCE computes a parameter of willingness to aid.

WINOVR takes this willingness parameter, applies it to forces available for aid, and establishes how much aid an N.G. is willing to give to each other needy N.G. that he can help.

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The bookkeeping in these routines is very complex; each nation-group is considered, and force needs and surpluses must include exogenous (loaned) forces, which makes things difficult. Further complicating things are the relationships between sub-routines. SHIFT computes needs, but _offers_ of aid are made, not on the basis of needs computed in SHIFT, nor on the basis of any magnitude of needs, but rather on the basis of the _existence_ of a need as calculated in LIANCE. This existence of a need may be different from the existence calculated in SHIFT. It appears, further, that the offers of aid computed in XLIANCE and WINOVR and used in REMOVE and SHIFT on the basis of existence of needs computed in LIANCE are offers from the previous week, and the existence is likewise a week old. In fact all the variables in LIANCE/WINOVR are a week old when used in SHIFT/REMOVE.

The difference in the "existence of need" in SHIFT and LIANCE is thus twofold. The first part, as we shall see, is that LIANCE includes a measure of projected needs based on escalation calculated earlier in the decision-maker (DM) submodel (though this is a week old when SHIFT is used). Second is that LIANCE increments needs as computed in SHIFT the previous week. Thus there is a time gap and an increment separating the two values of need.

It is not clear that the size of offers of aid must be determined a week before they are needed, which is what TEMPER says. Offers of aid lag behind needs for aid.

It is likewise not certain that the need for aid that an N.G. perceives for itself is entirely a function of a present situation, while a need for aid perceived by a potential supplier, though based on the same kind of calculation one week old, will include future projections of need because of escalation. This is an artifact of the sequencing of TEMPER routines. As LIANCE and WINOVR are called after SHIFT, and escalation is computed after SHIFT, in SHIFT an N.G. has no knowledge of its plans for escalation.

It is therefore suggested:

-- that SHIFT and REMOVE be transferred to the DM submodel.

-- that a nation-group's desire for escalation be computed on the basis of military data exclusive of aid, rather than as it is done now, where aid is conducted before escalation is made.

-- that military aid be determined on the basis of the sufficiency of present forces for the desired escalation.

-- that the escalation then be modified after aid transactions have been made.

It may be necessary to retain aid _offers_ from the previous week as an input to the desired escalation, as a measure of how much aid an N.G. can expect to get.

It may be of interest at some future time to examine in a laboratory situation such as a political military exercise or a simulation such as INS what time lags there might be in the consideration of information for both aid transactions and escalation decisions.

There are several things of interest in these five sub-routines.

(1) How are the military aid needs that TEMPER attempts to satisfy calculated?

(2) How are offers of aid calculated for dyads?

(3) How are offers matched with needs?

(4) What is the effect of transactions on alliance structure?

For (1) we look at SHIFT; for (2) we look at LIANCE, XLIANCE, and WINOVR; for (3) we look at REMOVE, and SHIFT again; for (4) we look at WINOVR, at all times keeping in mind the distinctions made above regarding need calculations and time lags.

It is necessary to accept some military definitions at face value and some military bookkeeping likewise, for it is considered beyond the scope of this project to evaluate purely military matters. Some comments will be made however if a

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particularly questionable statement or accounting procedure occurs. Such things as the cost-effectiveness of tactical force types can not be evaluated here. Also it is of little interest how the output from war routines originates for as noted above they are largely artificial and dependent on stochastic factors.

We are more concerned with the fact and magnitude of military aid, and the steps in decisions to give such aid.

The first proposition in SHIFT concerns the desired counterforce utility of a nation-group. When facing a conflict region opponent one would expect that a nation-group's desired measure of CFU would be a function of opponent MIL OPS levels and of CFU ratios in the conflict region in the immediate situation. And, this is what we find.

Bloc opponents of A are subscripted B and C. MIL OPS$_{A--B}$ means MIL OPS of A against B.

$$\text{Desired CFU}_A = \frac{(\text{MIL OPS } A--B)^2}{6} \times (\text{perceived CFU}_B + .1)$$
$$+ \frac{(\text{MIL OPS } A--C)^2}{6} \times (\text{perceived CFU}_C + .1)$$
$$+ \text{Base force requirement}$$
$$- \text{CFU}_A$$

Obtaining this equation requies the assumption of misprints in both volumes II and IV.

Let us examine the equation more closely. The equation has four terms. The first two give the desired CFU for use against each cf the conflict region opponents. The third term represents the amount of force that the nation-group feels is necessary for internal control. It is set in the Data Base. The fourth term is the CFU held by the nation-group of interest including forces loaned to the N.G., and loaned forces still in transit to the nation-groups

There are, then, four terms. The first two are equivalent in form and may be considered as one. The "base force requirement" is not well explained. This is unfortunate. As TEMPER may extend over 10 years' time it is unlikely that the internal political situation in all 39 N.G.'s will remain static. However, as this "base force requirement," CFU for internal control, is a function of national politics, and national politics are not treated in TEMPER, we can only ask how this exogenous variable is set. We suppose it is on the basis of aggregated national data.

The fourth term is straightforward and needs no discussion. The accounting procedure is, desired CFU = CFU desired against LCR opponents plus that needed internally minus what one alread has.* A negative desire means the N.G. has a surplus.

We return to the first two terms.

(1) A nation-group's desires for military forces may be expressed in terms of a cost-effectiveness calculation of desired counter-force utility.

This propostion assumes that national leaders will act in this matter on the basis of economically rational standards. Unfortunately, this is not necessarily so, as Secretary MacNamara has learned in his failures to get favorable action on some of his recommendations, and perhaps from his experiences with Gen. deGaulle as well. Both the Soviet MRBM investment and their ABM deployment are presumably not cost-effective as against alternative postures.

(2) A nation-group's desire for military force is composed of the unweighted sum of its force desires for use against its conflict-region opponents, and the

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*TEMPER defines this by a misleading term. Actually, this is the desired change in CFU. Consequently, the "negative desire" is a desire for a negative changed!

force it needs for internal control.

The notable thing about this proposition is that an N.G. may not desire force for export, as the U.S.S.R. U.K. and U.S. at the moment do.

We can note here that TEMPER, perhaps because of the limitation of war to conflict region opponents, reflects a non-expansionist, non-imperialistic conception of the world.

If it is felt that this deficiency should be remedied, one way to do it it would be to include a factor that is a function of the total ally value awarded by bloc members.

(3) The amount of CFU desired for use against a conflict region opponent is a function of the square of the MIL OPS against that opponent times the opponents' perceived CFU. This might be conceived of as "what you want to do and what he can do to stop it."

The term is, again:

$$\left(\frac{MIL\ OPS\ against\ opponent}{6}\right)2x\ (Perceived\ opponent\ CFU + .1)$$

The extra .1 is there to assure some desire for CFU even when the opponent is very weak. As perceived opponent CFU may range from 0 to 500, however, it appears that the .1 might be superfluous. What the actual, rather than allowable, CFU range is, we do not know.

Desired CFU against an opponent is a parabolic function of one's MIL OPS level. The numeration of six is chosen so that at a MIL OPS level of 6, an N.G. will desire the same CFU as its opponent has. As an N.G. gets above a MIL OPS of six, it desires an ever increasing force superiority. If MIL OPS are below 6, it is willing to have a force inferiority, see (IV-254, Fig. 4-13).

Perhaps 6 is an unfortunate parameter for opening with. If 6 "means local conventional war," (IV-359) parity in CFU is the least an N.G. can accept.

Furthermore, the form of the curve is probably altogether satisfactory. The only quick way of checking this assertion would be through interviews with military personnel. It is not clear why one would desire parity in CFU at MIL OPS = 6, and yet a 1.8/1 superiority at MIL OPS = 8. As there is no literature on this subject, we can only give an impression that an arc tangent curve with an inflection point at ZDOMZ = 5 bounded at a CFU ratio of 1/2 and 2 seems more reasonable.

It would seem that the most rapid change in CFU desires as a function of MIL OPS levels would be as an N.G. approaches limited war. This is hypothesized in THREAT.

There are several things not considered here.

(1) Opponent MIL OPS level--what level of operations is the opponent perceived to be carrying out? That this is not considered is a reflection of the fact that future needs are not anticipated by an N.G. in determining its needs for forces (but future needs are considered in determining whether or not an N.G. will get on the list of N.G.'s eligible to receive aid).

(2) The equation assumes that an opponent has all its forces available for use against the N.G. being considered. Yet it is possible that the opponent may be waging war against the third N.G. in the LCR. Thus the first term of the equation might be modified thus:

$$\text{MIL OPS}_{A--B} = \text{MIL OPS of A against B}$$

$$\left[\begin{matrix}\text{Appropriate}\\ \text{Scale} \\ \text{Factor}\end{matrix} \times \text{ATAN-1 (MIL OPS}_{A--B} -5)\right] \times \left[\frac{\text{MIL OPS}_{A--B}}{\text{MIL OPS}_{A--B} + \text{MIL OPS}_{C--B}}\right]$$

$$\times \left[\text{perceived}_A \ \text{CFU}_B\right]$$

Where MIL OPS levels used would include desired escalation, as discussed earlier. The second factor should be adjusted so it is never 0.

The revised equation for desired CFU would include two terms like the above, CFU for internal control, an amount of CFU desired for export if the country is "imperial," and the negative of the present CFU in the nation. The resulting equation would give CFU need.

The TEMPER equation is applied to all 39 nation groups. A list of all needy N.G.'s is ordered from most to least.

It is not possible to consider these routines in the order they are sequenced in TEMPER. To make sense out of them, we must consider them in an order that forms a decision-making process for military aid. Thus we must move to LIANCE and see how aid offers are calculated. We shall return to SHIFT.

LIANCE forms a new list of needs for N.G.'s, this time based on last week's needs computed in SHIFT (LIANCE as we are considering it is operating a week before the SHIFT we just considered. This out-of-phase treatment may be confusing, but it has to be done in order to make a coherent decision routine out of these five subroutines).

The purpose of this list is to (1) find out who needs aid, (2) to find out who has aid to give, and how much, and for whom it will be in the following week (the week we are discussing in SHIFT).

LIANCE takes the CFU needs and surpluses computed during that week (N-1) and updates them on the basis of escalation or de-escalation computed in CDALC and WINIT in the following manner:

The equation for needs in SHIFT is differentiated with respect to MIL OPS level. This _slope_ of desired CFU vs. MIL OPS level is then multiplied by the desired change in MIL OPS level.

The equation for what we shall call henceforth "Requests," rather than "Needs," the SHIFT term is:

$$\text{Request}_A = \text{Need}_A + (\text{change in MIL OPS level }_{A--B} \times \frac{2 \times \text{MIL OPS LEVEL}_{A--B})}{6^2}$$

$$\times (\text{perceived CFU}_B + .1)$$

Several comments about the "Request" equation need to be made.

(1) Although there is no indication of it, there seem to be a maximum of three terms in the request equation--"Need" + a term for change MIL OPS against each LCR opponent.

(2) Both in Vol. II and Vol. IV (pp.213 and 457 respectively) it is indicated that changes in MIL OPS levels and PSYCH OPS (ZPSYZ) levels are included here. It is further indicated that only positive changes in PSYCH OPS are counted; but no indication is given of how changes in PSYCH OPS are handled beyond this. Are they summed with MIL OPS changes? Averaged?

The listing suggests that changes in PSYCH OPS are considered only if there is no change in MIL OPS. There seem to be mistakes in the LIANCE listing.

We know of no way to state a proposition about the handling of changes in MIL OPS and PSYCH OPS, so we shall leave it as it is. Changes in MIL OPS are used to update present needs to include future needs. If MIL OPS is not to change, then positive PSYCH OPS changes are used to add a projection of future needs.

(3) Apparently, the old MIL OPS level is used in the REQUEST Equation. The result of this is given in Vol. II, p. 215. An N.G. will over-estimate the extra CFU it needs for escalation, and will under-estimate the amount of CFU it can spare because of de-escalation.

The magnitude of over-estimation increases with the size of the change in MIL OPS level.

The general proposition is that an N.G. will tend to request more CFU to support an escalation to MIL OPS = N than it would normally want to operate at the new MIL OPS level, other things being equal. An N.G. will desire to retain more CFU after a de-escalation to MIL OPS level = N than it would normally desire if it were operating at MIL OPS = N, other things being equal.

The larger the change in MIL OPS, the more distorted the request. One might say that the extra CFU represents an N.G.'s desire (due to uncertainty) for a safety factor. This seems to be a good idea. Unfortunately this whole calculation is not used to decide the magnitude of aid an N.G. will request, but instead it is used to decide who is eligible for aid. The "Request" does influence offer, however.

We might say, then, that nation-groups decide whether they will be able to offer aid on the basis of present and projected CFU needs; but nation-groups request aid only on the basis of present needs. The first half of this proposition makes sense. The second half is less plausible.

A "Request" of less than zero means the N.G. can offer military aid.

In LIANCE, if an N.G. has a surplus of CFU, exogenous forces are made available to their owners in an amount equal to the excess.

A bloc member can help a fellow bloc member against an opposing bloc member, but not against a neutral.

A bloc member can help a neutral against an opposing bloc member.

It should be noted that LIANCE is not well explained.

Once the "Requests" are formulated on the basis of CFU in the N.G. at present, the surplus list is scanned, and if an N.G's surplus includes exogenous CFU deployed in it, the exogenous CFU is entered into a list of surplus exogenous force for the owner. No mention is made of whether an N.G. can call back exogenous forces that are not needed where they are but are needed at home; likewise no mention is made of whether exogenous forces needed where they are may be called back if needed at home.

Further, no indication is given of how exogenous forces are treated in the following situation:

N.G.$_A$ has exogenous forces in it, owned by N.G.$_B$ and N.G.$_C$. On the basis of CFU in N.G.$_A$, there is a surplus, but the surplus is less than the CFU of either N.G.$_B$ or N.G.$_C$ in N.G.$_A$. What fraction of the exogenous forces owned by N.G.$_B$ and N.G.$_C$ are available to these owners for redeployment?

This question is avoided on p. 462, Vol. IV.

At any rate, unneeded exogenous force is in some way again made available to its owner for redeployment, and in the process an N.G. whose surplus was composed entirely of exogenous forces deployed within it may have its surplus reduced to zero.

How TEMPER handles an N.G. which needs to call back loaned forces for use at home is not explained.

Checking the numerical example of WINOVER we infer that an N.G. cannot recall exogenous forces still needed; but if it needs for use at home some exogenous forces no longer needed where they are deployed, this is treated as aid to oneself. (See IV, 478ff)

XLIANCE

XLIANCE is poorly described in both Vol. II and Vol. IV. Parameters are not clearly defined, so it is unclear how they are set and what they represent.

This subroutine calculates the willingness of each N.G. <u>with a CFU excess</u> to help each N.G. with a CFU "Request." We shall call this the WILLINGNESS COEFFICIENT, or WILLINGNESS.

The equation is

$$\text{WILLINGNESS} = \text{KEY} \times \text{REQUEST} \times [A_1[A_2 \text{ (STAGE)} + A_3 \text{ (PRXA)} + A_4 \text{ (PRXE)} +$$

$$A_5 \left(\frac{\text{GNP}}{\text{BLOC GNP}} \right)] + A_6 \text{ (A/A value)}]$$

We shall treat these terms in detail

    KEY = 1.5 if the needy N.G. is at war

       = 1.1 if he has a crisis (a rapidly increasing problem)

       = .7 if he just has a problem

    REQUEST = the "Request" of a needy N.G. as computed in LIANCE

    STAGE = the amount of forces that A has stationed in B at the moment if B is a bloc member; or, some measure of past offers of aid to B if B is a neutral (not well explained)

    PRXA = proximity of needy to supplier. This is either 1, 2, or 3; these values are set into the data base and aggregated. They are soft, and a function of both geographical nearness and "political nearness," whatever that means--(see VII-313). Highest values are for closest nations.

    PRXE - proximity to common enemy--supposedly set in WINOVR, but not given there.

    $\frac{\text{GNP}}{\text{BLOC GNP}}$ = in this context, GNP of <u>B</u> over GNP of Bloc. We assume that if B is a neutral, the denominator is the GNP of all neutrals.

<u>A/A value</u> is the ally value A has given to B. This is 0 if B is a neutral.

The constants A_1 -- A_6 are as follows:

A_1 = .7

A_2 = .4 (for staging)

A_3 = .028 (IV-467,-469) for ally proximity

= .15 (II-219)*

A_4 = .15 (IV-467,-469) for enemy proximity

= .25 (II-219)*

A_5 = .2 for GNP ratio

A_6 = .3 for A/A value

We may now restate the equation:

WILLINGNESS = KEY x REQUEST [.28 STAGE + .0196 PRXA + .105 PRXE

$$+ .14 \frac{GNP}{BLOC\ GNP}$$

$$+ .7\ A/A\ value]$$

From the numerical example (IV-469) it appears that each term of (constant x variable) is of about the same order of magnitude, though the ally proximity term is the smallest.

Propostions, then, are that:

The willingness of an N.G. to supply aid to another nation-group increases as:

(1) the seriousness of the needy N.G.'s situation increases (KEY);

(2) his need for CFU increases, including present and projected needs;

(3) the amount of forces the supplier has stationed presently in the needy N.G.,

   or if he is a neutral, the past offers of aid to the neutral;

----

*The TEMPER listing for XLIANCE does not clear up the conflict. Vol. IV values will be assumed correct.

(4) the needy N.G.'s closeness to the common enemy (remember that this variable

   is really unexplained and undefined, the measure is rough, and proximity

   is a bad name);

(5) the needy N.G.'s closeness to the helper (as discussed above);

(6) the friendship of A towards B.

Bloc members are more willing to give aid to fellow bloc members than to

neutrals.

Note that the A/A value term is one of the strongest in the equation.

The willingness coefficient is, however, artificial. It represents how

willing an N.G. would be to supply aid to another N.G. if it were able to supply

aid to all the N.G.'s that it wished to supply, and to the extent it wanted. The

artificiality comes from the fact that the surplus of the supplier is not considered,

while in reality, willingness to supply one nation cannot be so easily separated

from surplus, or from willingness to supply other nations. We doubt if such a

calculation is ever made in the real world. In the real world, willingness to aid

is dependent on both needs and surpluses, and also on some form of calculus of

variations solution to the problem of maximizing one's aid in terms of perceived

threats to oneself and one's friends within the context of an alliance system

where aid programs are consciously coordinated. Such a solution is, of course,

only possible if internal politics are neglected, or are included in the equations.

WINOVR

In WINOVR the __willingness coefficient__ is turned into a magnitude of aid that each surplus nation is willing to supply to each needy nation. Most of these dyads will be zero because of constraints on who can aid whom, and because of A/A values of zero.

WINOVR computes aid offered from both indigenous and exogenous (loaned out) forces owned by the helping N.G. The two are calculated separately, and if either exceeds a threshold of CFU = .005 the value is set aside and used in SHIFT and REMOVE the week following its calculation (as discussed earlier). A record of offers is kept for the neutral STAGE factor used in the __willingness coefficient__ equation. Ally and alignment value are updated to reflect effects of the offers.

In WINOVR, an N.G. may offer excess indigenous forces, or it may offer exogenous forces no longer needed where he has loaned them (as calculated in LIANCE).

Offers of each type of force are calculated separately. Note here that we are working with force as measured by CFU only and are not considering different tactical force types as we will in SHIFT.

We will continue by considering aid from indigenous forces first.

An N.G. makes a consignment of indigenous force available to a needy N.G. in the following manner.

(1) The amount of aid N.G.$_A$ is willing to give N.G.$_B$ is N.G.$_A$'s surplus times the willingness coefficient, A to B, divided by the sum of all willingness coefficients calculated for A.

$$\text{RATIO} = \frac{\text{WILLINGNESS (A,B)}}{\sum_N \text{WILLINGNESS (A,N)}} \times \text{INDIGENOUS SURPLUS}$$

This calculation is done for each potential helper for all N.G.'s it is willing to help.

A similar calculation is done with exogenous force surpluses.

$$RESERV = \frac{WILLINGNESS\ (A,B)}{\sum_N WILLINGNESS\ (A,N)} \times EXOGENOUS\ SURPLUS$$

So that each nation group allots a fraction of its total surplus to each needy N.G. it is willing to help. For a given helper:

$$AID_{A \to B} = \frac{Willingness\ of\ A\ to\ help\ B}{(Willingness\ of\ A\ to\ help\ all)\ N.G.'s\ it\ will\ help} \times (Indigenous + Exogenous\ surplus)$$

Once these calculations have been made for all possible aid dyads, the amount of aid offered to each needy nation is summed. If the aid offered exceeds the aid requested (in LIANCE), then all offers are reduced by a factor $\frac{REQUEST}{TOTAL\ OFFERS}$.

The full equation for aid from A to B is then

$$AID_{A \to B} = \left[\frac{Willingness\ of\ A\ to\ help\ B}{Willingness\ to\ help\ of\ A}\right] \times \left[Total\ Surplus\ of\ A\right]$$

$$\times \left[\frac{Request\ of\ B}{Total\ Offers\ to\ B}\right]$$

Where willingness = willingness coefficient computed in XLIANCE, the last factor may not exceed 1.

This aid equation is computed for all possible dyads.

The way in which a surplus of offers to an N.G., over that N.G.'s request, is handled gives a proposition: MIL AID is non-competitively handled in cases where offers exceed needs. This reflects a non-expansionist outlook, as bloc members do not compete for A/A value.

The amount of its surplus an N.G. is willing to give another N.G. in military aid is a function of its willingness to aid that N.G. divided by its total willingness.

We have noted before that "willingness" is a function of the seriousness (war, crisis, problem) and magnitude (REQUEST) of the needy N.G.'s situation; prior commitment to that N.G.; friendship toward that N.G.; the needy N.G.'s importance

in its bloc, as measured by GNP (BLOC GNP); and some very fuzzy proximity measures.

The amount of aid each surplus N.G is willing to give each needy N.G. is calculated and stored for use next week in REMOVE.

Offers to neutrals are recorded as a fraction of the neutral's desired + owned CFU. This value is accumulated approximately over time for use as STAGE in the willingness equation discussed in XLIANCE.

Before returning to REMOVE, we shall discuss changes in A/A value as a function of MIL AID offers.

Apparently no decrease in A/A value is made by a needy N.G. for an N.G. which does not help it.

Military aid offers increase the friendship of the receiver for the donor.

Lack of military aid offers does not damage the friendship between the countries.

This is a necessity, for an N.G. with a surplus will offer aid to any needy bloc N.G. to which it has assigned ally value, and to any neutral in conflict with an opposite bloc member.

Remember that a bloc member will not aid bloc members against neutrals, though how this is checked out is not clear since requests for aid in LIANCE are a function of needs against both LCR opponents.

(See IV-458 for above restriction. We accept it only because it is never contradicted, not because it is confirmed.)

Increments in A/A value awarded by needy N.G.'s to offerers of aid are calculated as follows.

$$\text{INCREMENT} = \left[1-\text{present A/A value}_{B--A}\right]\left[\tanh\left(\frac{\text{fraction of B's Request that A is willing to fill}}{\text{External Dynamism of B}} \times \frac{1}{200}\right)\right]$$

The increment added to the receiver's A/A value awarded to the offerer is a function of the unassigned A/A value.

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Therefore, the lower the friendship of B toward A, the larger will be the increment of A/A value he awards in response to an offer of MIL AID from A.

MIL AID offers, not MIL AID itself, cause a nation-group to increase its friendship. This is necessary in TEMPER because offers and actual aid are not the same, as we shall see in REMOVE and SHIFT.

Awards of A/A value increase **linearly** with the fraction of a request an offerer is willing to fill, and decreases **linearly** with external dynamism of the receiver.

We say linearly because the hyperbolic tangent is approximately linear for arguments up to at least .1 (tanh (.1) = .09967, tanh (.09) = .8976, tanh (.05) = .04996, etc.). In fact, for argument up to .01, tanh (X) = x.

As long as the constant in the equation $\lfloor K = DMVAL (3)\rfloor$ is set as high as 200 it is unlikely that the argument of the tanh function will exceed .1. Let fraction of Request = 1, than if external dynamism = .05, argument = .1.

Checking Vol. VII, it can be seen that no nation is assigned ZEXTD below .3, and that the average external dynamism is between .6 and .7.

Thus we suggest that the tanh function be abolished and the value of the argument be used itself.

We have no quarrel with the linearity assumptions, as the range of the increment is small.

Another proposition is that neutrals and bloc members respond to offers of aid in the same way.

In summary let us note that LIANCE, XLIANCE, and WINOVR each do very little. LIANCE computes "requests," updating "needs" from SHIFT by considering changes in MIL OPS. XLIANCE computes a general willingness coefficient, and WINOVR computes consignments of aid, or **offers**, for use next week in SHIFT; and it increments A/A value in response to these offers.

And now we can return to SHIFT and REMOVE.

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REMOVE and SHIFT

REMOVE now takes offers of CFU and translates them into offers of specific tactical force types. The tactical force type that is least cost-effective for the N.G. offering it is offered first. If that force type does not fill the need, as computed on SHIFT, not in LIANCE, the next least cost-effective is examined and so on until the helper's offer to the needy N.G. is fulfilled. This is done for all aid dyads.

In SHIFT these specific offers are used. The needs are filled by bloc in sequence. Western Bloc needs are considered first, then Western aid to Neutrals, then Eastern Bloc needs, and then Eastern aid to Neutrals. Within these categories the N.G.with the largest need (as computed in SHIFT) is treated first. It accepts the forces most cost-effective for it. This calculation is composed of the cost-effectiveness of the force and the shipping costs of that force type. Acceptance of aid is calculated on the basis of this cost-effectiveness.

Thus we may find paramilitary forces being given to an N.G. which needs nuclear infantry. These routines are then somewhat artificial. The aid transactions are made on the basis of <u>the helper offering his least cost-effective forces first and the receiver taking the most cost-effective forces he can get</u>. A constraint on the offers is that the <u>helpers try to maintain the same mix of tactical forces that they started with</u>. It would take another ten pages to go through the aid transactions in detail. But any propositions besides the three above are actually enmeshed in bookkeeping.

(1) Helpers offer forces least cost-effective to them at home first.

(2) Receivers take forces that will be most cost-effective to them, but they take what they can get.

(3) Helpers try to maintain the same mix of forces they started with at home throughout the aid process.

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(4) The worst needs are met first to the extent that offers can fill them. Needs are treated in rank order within blocs.

(5) Fellow bloc members have preference over neutrals for aid from members of a major bloc.

(6) Neutrals do not give aid.

As long as left in this form, aid transactions seem reasonable as a first rough approximation.

We have not checked the bookkeeping to see if SHIFT and REMOVE do conduct transactions as the documentation would have us believe. We cannot be sure that it is exactly that way but it seems close enough on the basis of a quick check.

There are some peculiar things with these decision routines. One is that the "leashing" of Taiwan must be artificially simulated by some such device as setting its force needs for internal control very high.

Unlikely aid can occur, such as Israel aiding Western Europe and Britain; an offer of this nature is made in a WINOVR example.

It is far from certain that in the real world aid is offered and accepted on such strictly cost-effective criteria.

DECISION MAKER SUBMODEL

DMFILE

Several, though not all, of the propositions in DMFILE are of interest. The first concerns ally value.

All awards of ally or alignment value are decreased slightly each week. The purpose behind this is to make A/A value decrease slightly in the absence of trade or aid. As this is one of only two ways in which A/A values can decrease, it is important.

All ally or alignment values will decrease slightly each week. This decrease may or may not be large enough to offset increases due to aid and trade.

The new value = the old value multiplied by one minus a sine squared function of the old value.

The sine squared function is set so that A/A value of 0 and 1 correspond to an argument of 0 and π respectively. The sine squared function is divided by 480 so that the maximum decline is .00208 of the old value, at A/A value = .5.

We may call this a "natural decrease." It is largest near A/A value = .5 and very small as A/A value approaches either 0 or 1. The sine squared function is more "pointed" than a sine function.

There are two questions to be raised about this updating.

(1) There is no need for it if the A/A value has been increased due to aid or trade. In the absence of aid or trade the decrease seems reasonable. When there is aid or trade there seems no reason to wipe out small increases, as this function does.

(2) While the sensitivity at middle levels makes some sense, there is a factor that has been neglected--external dynamism. The higher external dynamism, the larger this "natural" decrease should be.

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Therefore, it seems reasonable to ask that this function be placed in WINOVR so a check can be instituted to see if A/A value in a dyad has been increased that week. If it has, then it should not be decreased. Next, account of external dynamism should be taken, as in these FORTRAN-type statements.

If (ZFVAL$_{(\text{PRESENT})}$ - ZFVAL$_{(\text{END OF LAST WEEK})}$) 1,1,2

1. ZFVAL = ZFVAL (ZEXTD) $(1 - \text{SINE}^2 (\pi * \text{ZFVAL})/480)$

2. ZFVAL = ZFVAL

These recommendations are quite easily executed, adding little to computer time.

DMFILE recalculates desired land fraction, the fraction of the conflict region that each N.G. wants to own.

The mathematics are complex so we shall try to avoid all the detail.

First the value of the land an N.G. occupies, and the value it places on the land of its conflict region opponents is calculated.

Land value is a function of two terms.

(1) The ratio of quarterly GNP per square mile of the N.G. being valued to the sum of GNP per square mile for all N.G.'s in the conflict region.

(2) This same ratio multiplied by a variable much like TACTICAL THREAT. It is XFTHRT.

$$\text{XFTHRT} = .5 + .4 \text{ arc tan} \left(\frac{\text{MIL OPS} - \text{TEST} - 5}{2} \right)$$

Where MIL OPS is the MIL OPS of the valuing N.G. against the N.G. being valued, and TEST is the ratio of valuing to valued nation-group's CFU, scaled between -1 and +1 as done in calculating tactical threat.

XFTHRT represents the threat that the valuer holds for the valued.

If an N.G. is valuing itself, XFTHRT = 1.0

Value of B to A =

$$80 \times \left(\sqrt{\text{RATIO}} \right) \quad x \cdot 40 x \cdot \sqrt{\text{RATIO x THREAT of A to B}}$$

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The value of B's land to A is a function of the square root of the ratio of GNP per square mile for B to the sum of the GNP per square mile of all the N.G's in the conflict region.

It is also a function of the square root of this ratio multiplied by a measure of the threat of A towards B as indicated by MIL OPS levels and CFU ratio of A to B.

This is a very complex calculation for such a soft variable, and the most complex part has the least influence on the value of the variable. The threat measure varies between zero and one.

Further, we see no obvious reason for using the ratio of the area GNP to the sum of the area GNP values in the conflict region. The denominator of this ratio holds no obvious meaning; however, the area GNP for the entire conflict region makes more sense as a denominator for the resulting ratio would be a measure of the relative value of the land of B to the value of the conflict region.

The contribution to value that results from the second term of the equation seems to be in part a function of the desire to win a conflict as measured by MIL OPS, but it is really not clear what the second term represents.

Our recommendation is that the land values be checked in an actual run of TEMPER. It seems that the value A will place on B's land is a function of the degree to which the resources, skills and special characteristics (such as ports) of that nation group complement the resources, skills and characteristics of A.

It would therefore make more sense to set land values into the DATA BASE and aggregate them. In aggregation there would be some duplication of values but this is not as serious as it seems, for a nation group can always use another port or more rice, or what have you.

Barring this, several things might be done. First the area GNP ratio could be recalculated, as suggested to measure the relative economic value of the land more accurately; or the ratio could also be

AREA GNP of A
AREA GNP of B

The military considerations could be handled as they are now, except that THREAT could easily be scaled from 2/3 to 3/2 and then be used to multiply the area GNP ratio inside the square root sign, producing substantially the same curves as are now produced.

We may note two major propositions:

(1) The value A places on B's land is a square root function of the area GNP ratio, which we questioned above.

(2) At a constant area GNP ratio, value increases with the square root of the THREAT of A towards B. This increase becomes less pronounced as the THREAT increases and as the area GNP ratio decreases. See IV-313 for a graph which illustrates the functional relationship of these terms.

The complexity of this calculation can be seen as unnecessary when one realizes the small part it plays in the updating of desired land fraction. Of course, this is also a strong reason for not working on changing it.

The desired land fraction, the fraction of the conflict region desired by Nation Group A, is initialized by the player and is updated as follows:

New Desired
Land Fraction = .025 (AVERAG or ZLAND, whichever is larger)

+ .975 (old desired land fraction).

ZLAND is the land fraction presently occupied. AVERAG is the average of the land fraction historically held, a soft value set by the player, and a function of the weighted sum of the value A places on the land of his conflict region opponents.

The land values we have just discussed comprise no more than about 1-1/4% of the desired land fraction equation apiece, as desired land fraction is initially set by the player.

The second term in AVERAG is not clearly explained. It appears that this

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term, WANT, measures the fraction of opponent land that A wants as a function of the value A places on that land, and is bounded so that at one value no fraction of the opponent's land is desired, and at a higher value the entire land of the opponent will be desired.

The result of this calculation is that if a nation group puts a high value on the land of its LCR opponents and/or feels it once owned a substantially larger fraction of the LCR than it does now, its desired land fraction will increase.

If, on the other hand, it feels that the value of the opponents' land is low, or that its historical fraction is little larger than it holds now, it will tend to be satisfied with the land it has, and the desired land fraction will tend toward the fraction presently held.

It should be remembered that the value placed on opponent's land is a function of its relative area GNP value, and the MIL OPS against its opponents.

The recommendations for changing land valuations should be considered, for though these make but a small contribution to the total desired land fraction, they may account for most of the change.

We may note several propositions before moving on:

(1) If the GNP of an N.G. increases relative to its conflict region opponents, the opponents will desire that N.G. more, and their desired land fractions may increase.

(2) If A becomes involved in a war with B, A's desired land fraction will increase. This is, however, less important than the proposition just discussed, as military operations are a weak influence on land valuations.

(3) CPU ratios have little effect on land valuations. We may therefore conclude that the only psychological factor operating here is the historical one.

Desired land fraction is perceived in PERCEP, is used in problem recognition, and is a minor variable in deciding whether or not to escalate.

STRDM

STRDM is called semi-annually to calculate the population losses resulting
from strategic pre-emption. What there is in this subroutine that is not mere
bookkeeping is footnoted. The calculations are very complex and we do not feel
prepared to either judge them or explain them.

We suspect, however, that there is no need to go through all the calculations.
The curves of population loss as a function of who pre-empts, of the deliverable
megatonnage, of population density, of hardening, and of one or two other factors
could be approximated adequately by simpler equations. There is probably no need
for the complexity and precision offered here. It seems a case of generating
8-place data from 2-place data; and further, of using this 8-place data later
in strategic threat where it does not have to be so precise. Does the Defense
Department make policy calculations on the basis of population loss fractions of
greater than two-place accuracy? How important is a difference between population
loss ratios of $\frac{1.5}{1}$ and $\frac{1.7}{1}$ for making foreign policy?

So although we have not evaluated the accuracy of the calculations in STRDM
we question the necessity for them.

PROREC

PROREC is a long subroutine. It computes problems, i.e. differences between desired situations and perceived situations.

Certain problems are set up for the bargaining routine. The first of these concern power ratio motivations and are calculated for strategic owners. It is assumed that the desired power ratios, or power ratio motivations (perceived in PERCEP and XPERCE, updated quarterly in KULTUR) of the bloc leader are used by all strategic owners in the bloc.

There are two aspects of the strategic budget problems, those that concern power ratio motivations. The problems are computed for R and D spending, strategic forces budget, and tactical force O and M costs. We queried earlier why tactical budget rather than tactical O and M costs are not used; the former would include both procurement and O and M costs.

The problems are computed quarterly and accumulated over a year, since bargaining about these quantities is done yearly, and budget adjustments are made yearly also.

The form of the equation is:

THIS QUARTER'S PROBLEM = ACCUMULATED PROBLEM + QUARTERLY PROBLEM INCREMENT.

The first aspect of the calculation is the way the increments are accumulated. This is done so that quarters are weighted equally.

For example:

--in the first quarter, the increment is multiplied by 4, so that is weighted as if it is a year.

--in the second quarter, the first quarter's increment is divided by two. As the increment had previously been multiplied by four, the actual increment is now effectively weighted by 4/2 or 2. The second quarter increment is also multiplied by 2 now.

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--the third quarter old problem is now composed of two equally weighted quarterly increments. The old problem is multiplied now by 2/3, giving an old problem composed of the two previous quarterly increments multiplied by 4/3. The new quarter's increment is likewise weighted by 4/3.

--in the last quarter the weights are 3/4 and 1 so that the net result is that the total problem for the year is the sum of the four quarterly problems.

This is all very clever, but an equivalent way of programming this would be to compute the problems quarterly and add them.

for quarter 1--PROBLEM = PROBLEM $_1$

for quarter 2--PROBLEM = PROBLEM + PROBLEM$_2$

for quarter 3--PROBLEM = PROBLEM + PROBLEM$_3$, etc.

The scaling is unnecessary. In the first quarter of each year PROBLEM could be set equal to zero before the first quarter calculation is made.

The parameters $\frac{QTR}{QTR}$ 1 and $\frac{4.0}{QTR}$ 1 are superfluous and their elimination streamlines PROREC slightly.

We can discuss how these quarterly problems are computed. We shall treat only the R and D problem of a strategic owner. The others follow in the same form.

The problem is expressed in terms of a desired increase in a strategic owner's spending.

The strategic owner's quarterly R and D spending is multiplied by the following factors:

$$\left(\begin{array}{c} \text{desired R\&D spending} \\ \text{ratio of your bloc} \\ \text{leader to opposing} \\ \text{bloc leader} \end{array} \right) \times \left(\frac{\text{Perceived opposing bloc leader's R\&D spending quarterly}}{\text{own bloc leader's R\&D spending quarterly}} \right) - 1$$

The first term is the desired ratio of your own bloc leader's R and D spending to the opposing bloc leader's R and D spending.

The second term is the inverse ratio of the actual values as the NG perceives them.

If the desired ratio equals the perceived actual ratio (used inverted here), then the product of these terms is unity and there is no problem that quarter as the factor becomes 1 - 1 = 0.

If the desired ratio is smaller than the ratio of one's own bloc leader's spending to perceived opponent bloc leader spending, say 4/3 and 3/2 respectively, then a negative problem exists for that quarter and the nation group will desire to reduce its spending by 1/9: 4/3 x 2/3 - 1 = 1/9.

If the desired ratio is larger than the perceived inverse ratio, say 3/2 and 4/3 respectively then the NG will desire to increase its spending by 1/8 in this example: 3/2 x 3/4 - 1 = +1/8.

If one accepts the implied notion of problems and of power ratio motivations, then these calculations of problems are straight-forward and acceptable.

As the perceived spending ratio gets smaller than the desired spending ratio, the amount one wishes to increase one's own spending increases; as the perceived ratio gets larger than the desired ratio, then the negative problem, a willingness to decrease spending results. If perceived and desired ratios are equal there is no problem.

The next problems computed are the problems that the opposing bloc leader is perceived to have. These problems are accumulated quarterly by the same process as before, which we consider unnecessarily cumbersome.

The twists and turns of perceptions and couunter-perceptions can be very confusing. Each of the two bloc leaders perceives the problems the opposing bloc leader has concerning the bloc leader's budget bargaining array. In this problem perception, the problem that the Soviet Union has with its bloc leader's budget

bargaining array is perceived by the United States in terms of Soviet expenditures as the U.S. perceives them, actual U.S. expenditures, and the power ratio motivations that the U.S. perceives the Soviets to have. The end of all this is that the U.S., for example, is able to make an estimate of the size of the Russian's problems, and the Russians conversely, can make an estimate of the size of the Americans' problems. These estimates are then used to determine the magnitude of the offers that are made in bloc leader budget bargaining.

These problems are perceived by bloc leaders only, each perceiving the other, and they are problems the opposing bloc leader is perceived to have regarding the bloc leader's budget bargaining array. This array was perceived in XPERCE and consists of five variables:

    (1) quarterly GNP

    (2) quarterly military budget

    (3) quarterly R and D budget

    (4) quarterly strategic budget

    (5) quarterly tactical force O and M costs.

No problem is perceived for GNP. The validity of the problem perception is dependent on the validity of the perception routines and of the power ratio motivations. If these are accepted, then the problem perceptions are straight-forward.

Remembering that the problem is accumulated quarterly as before, we can discuss only the second term of the problem equation:

PROBLEM = old problem + this quarter's problem.

Each quarter the following problems are computed:

Perceived Defense Spending problem of opposing bloc leader

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$$= \frac{\text{ZMILI}}{10} \quad \text{perceived bloc leader quarterly Government expenditures}$$

- perceived bloc leader quarterly military expenditures.

Perceived R and D spending problem of opposing bloc leader

= perceived opposing bloc leader power ratio motivation for R and D

x Own R and D spending

-perceived opposing bloc leader R and D spending

Perceived strategic and tactical expenditure problems are computed by an analogous formula with the proper power ratio motivations, and real expenditures substituted accordingly.

The first term gives the perceived desired quantity; the second the perceived real quantity. The problem is then the perceived desired military, R. and D, strategic or tactical expenditure minus the appropriate perceived real expenditure.

The equation gives a perceived problem in terms of a desired increase or acceptable decrease in expenditure in one of these four areas. The calculations are, as already said, straightforward.

The only proposition here is that a problem is the difference between desired and actual values and that a perceived problem is the difference between perceived desired and real values.

The only difficulty with the perceived bargaining problems of the bloc leaders is that ZMILI, military spending motivation, is used in the first one. Because there is no power ratio motivation for military budget, the perceived value for the opposing bloc leader's desired military spending is computed from his perceived government expenditure multiplied by his real "military spending motivation," ZMILI. ZMILI is 10 times the fraction of one's government budget desired for defense

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initially, and is updated in KULTUR. Because the actual value is used the equation for this problem is different from the other perceived problem equations. It would seem more consistent to use a perceived value of ZMILI here. Other than that no changes are necessary, and that one is not absolutely necessary either.

PROREC continues to calculate the following for all nation-groups:

(1) Defense budget problems
(2) Average tax rate
(3) Necessity for trade

It is necessary to discuss only the first of these. The second is merely a comparison of the past average tax rate with present desired tax rate. The third is economic, and is a function of sector demands, sector surpluses, and balance of payments. It measures the need for trade and is used in PDCNTL.

Defense budget problems for all Nation-Groups are computed in a manner similar to other problems. They are computed quarterly and accumulated for use annually in the manner that has been described. The quarterly increment for one's own defense budget problem is:

$$\text{desired fraction of gov't expenditure for defense} \times \text{gov't. expenditure} - \text{military expenditure}$$

The propostion here is as before: a problem is the difference between actual and desired values.

Note may be made of the notion of accumulation. This is necessary because motivations and expenditures may change quarterly, and these problems are used in the model annually. The problem magnitude for the year is thus the value desired for use in bargaining. Because budgets are calculated yearly, and all the problems discussed so far concern budgeted expenditures, it is not possible to bargain over these problems more frequently.

A weekly problem is computed for each N.G. with respect to each conflict region opponent. The problem has four components:

(1) problem resulting from an opponent's perceived MIL-OPS level.

(2) problem resulting from an opponent's perceived PSYCH-OPS level.

(3) problem resulting from differences between one's own and the opponent's CFU.

(4) problem resulting from opponent's desired land fraction.

We shall treat these in order.

The first component of the weekly problem is a function of the Nation-Groups' PSYCH-OPS and the opponents' perceived MIL-OPS. The following value is calculated for Nation Group A and opponent B:

$$(PSYCH\text{-}OPS_A + Perceived\ MIL\text{-}OPS_B - 10)$$

where PSYCH-OPS are for A against B and MIL-OPS are for B against A. Remember that operations levels vary from 0 to 10 (see III-359).

If this value is greater than zero, A has a problem. If it is negative, then there is a negative problem which represents an ability to lower the PSYCH-OPS level without harm to A.

This value is divided by 2 and the quotient forms the argument of a hyperbolic tangent function. The effect of large values is thus attenuated. This problem component varies from -1 to +1. It is difficult to make a propostion out of this equation, for PSYCH-OPS and MIL -OPS are not strictly comparable, and the meaning of a given level of either is not exact. MIL-OPS levels of 6 and 9 have certain consequences which give these levels a precise definition, but these are the only two well-defined values of either variable. If we consider that a given PSYCH-OPS level is a threat of the corresponding MIL-OPS level we can evaluate this function.

It seems reasonable to link PSYCH-OPS, threat levels, closely with MIL-OPS, at least to the extent that PSYCH-OPS can be expected to usually exceed MIL-OPS. Further we can expect that an N.G. will threaten an opponent at a level related to, and probably exceeding, the MIL-OPS of that opponent against the threatening N.G.

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For example if B is conducting MIL-OPS = 7 against A, then A would look foolish threatening a retaliation at level 4, for this would be a very unthreatening threat. On the other hand, a threat level of 8 makes some sense, as this means that A is threatening to meet B's MIL-OPS level of 7 with its own retaliation at a MIL-OPS level of 8. Checking the equation, however, we find that both of these pairs of values will give a positive value to the problem component. If A perceives that B's MIL-OPS against it is 7, then it will have no problem component resulting from B's MIL-OPS only if its own threatened retaliation is at a level of 3 or less. This is foolish. Any time the perceived MIL-OPS of an opponent exceeds your threatened retaliation you have a problem, meaning that you must either raise your threat or induce your opponent to lower his MIL-OPS level against you.

We may say, then, that TEMPER finds a problem for A whenever the sum of A's PSYCH-OPS against B and its perception of B's MIL-OPS against A exceeds 10.

Thus, the smaller the MIL-OPS against A, the more A can threaten without a problem. The larger MIL-OPS against A, the less it can threaten without a problem. This last assertion is unrealistic.

Thus the problem component resulting from the equation is invalid and meaningless (XPROB (ND, 1), see IV-364).

An improved formula would result from using (PSYCH-OPS) minus (perceived MIL-OPS). This would mean that if an N.G's threats of retaliation do not match the operations against it, a problem will result, caused by opponent MIL-OPS level.

The factor of 10 has the effect of comparing threat levels with 10-(MIL-OPS) levels, and there is no relation between the two.

The relation can be thus restated to say that a nation-group has a problem caused by opponent MIL-OPS levels if its PSYCH-OPS level does not exceed 10-(perceived opponent MIL-OPS level), and has no problem or a _negative_ problem if its

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PSYCH-OPS level is less than 10-(perceived opponent MIL-OPS).

We suggest changing this to a comparison of the two values:

(perceived opponent MIL-OPS) - PSYCH-OPS)

so that if a Nation-Group's threat level does not exceed the MIL-OPS it perceives conducted against it, there will be a problem. If it does exceed the MIL-OPS value, the N.G. will feel able to reduce its PSYCH-OPS level in the bargaining routines in return for its opponent's reducing some value that is causing the threatener a problem.

For, in fact, this is what the problems are used for: to find what variables A wants B to reduce, and what variables A may reduce in order to make a bargain.

A problem should result when the perceived value of a variable is too high according to some standard. This will mean that the perceiving N.G. will desire that the perceived N.G. reduce the value of that variable. The necessity for creating values that an N.G. may reduce to make a bargain determines the form of the problem equations to the extent that two-variable comparisons are the most economical--thus perceived MIL-OPS is compared with PSYCH-OPS.

We may then note that for A, a problem in an opponent's MIL-OPS level is caused by its relation to the A's PSYCH-OPS.

Besides the form of the equation, we may also quarrel with the variables. It is not clear why the standard for deciding whether A wants B to reduce its MIL-OPS level is A's PSYCH-OPS level. The desire for an opponent to reduce his MIL-OPS level should always exist, whether A is an attacker or not, for in that case he should wish his opponent to give up. This desire for a reduction in opponent MIL-OPS is more likely to be a function of the perceiver's desire for conflict and his expectation of winning any conflict, as well as the damage the conflict is causing him. The problem equation as it stands is a function of opponent MIL-OPS level in that the higher the level is, the more likely it is to cause a problem. This is, however, an indirect way of getting this result.

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One may, on the other hand, interpret PSYCH-OPS as a "willingness to fight"
that includes all the considerations in the previous paragraph. The higher the
MIL-OPS against you, the more willing to fight you must be in order not to have
a problem. This is exactly the problem equation suggested above, and it is exactly
the opposite of what the equation presently proposes. PSYCH-OPS then, is to be used
as a measure of willingness to fight. Therefore, if this recommendation were
accepted, TEMPER would have to be checked to see that PSYCH-OPS may not be a
bluff; as far as we can tell, however, bluffs do not exist in TEMPER.

We can see here some of the difficulty in evaluating TEMPER. The equation
must be looked at for what is done with it. Here XPROB (ND,1) is an input to the
bargaining routine, and it may be reduced if an opponent reduces his MIL-OPS level.

In reciprocation, Nation-Group A, which has the problem, may reduce a different
variable in another equation.

To evaluate XPROB (ND,1) one must try and figure out what the variables might
represent. The evaluation took three steps:

(1) Checking values in the equation to see if they made sense.

(2) Changing the functional relationship so that it made more sense.

(3) Examining the variables in the equation to see if there was a necessary
relation between them. This required a decision about what PSYCH-OPS was a
surrogate for. We decided that "willingness to fight" was as good a definition
as any--but this is subjective, as are all such interpretations.

Because the creators of TEMPER do not themselves state what phenomena a
variable is a surrogate for, and thus do not give any rationale for the interpreta-
tion, one must go through the interpretation for one's self. Therefore the inter-
pretation and evaluation of equations and the extraction of propositions is arduous.
In addition, in such a complicated document misprints, mathematical errors (as in

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scaling in PERCEP) and conflicting statements in the documentation compound the difficulty.

The second component of the weekly problem computed for all nation-groups is the problem that results from the opponents PSYCH-OPS level. We shall use nation-groups A and B again, with the problem being calculated for A.

The problem equation is analogous to the previous one:

$$\text{PROBLEM} = \text{Tanh}\left(\frac{\begin{array}{cc}\text{MIL-OPS of} & + \text{A's perception of B's}\\ \text{A against B} & \text{PSYCH-OPS against it}\end{array}}{2} - 10\right)$$

This routine has the same difficulties as before, consider:

MIL-OPS = 2, perceived PSYCH-OPS = 6

In TEMPER the result is no problem. In real life, there is some problem as A would desire that B reduce its threats.

Consider: MIL-OPS = 8, perceived PSYCH-OPS = 4

Here A is conducting full-scale conventional war against B, and B is threatening guerilla action. Certainly a problem results, but not be the equation.

The documentation argues that it is the sum of the two variables that is important in generating a conflict. This sounds plausible but the result is absurd, for conflict exists in both examples above (see IV-365).

If PSYCH-OPS levels were compared, and each scaled so that high values were more important, then the sum of both N.G.'s PSYCH-OPS levels would hold some meaning for the initiation of armed conflict. Take for example the idea of squaring PSYCH-OPS, and if the sum of both levels squared exceeded 32, then MIL-OPS of level six would result. Then we would have a proposition about how wars start--by threats getting too high. But as it stands now, one can have "problems" when there appears no reason to have problems, given the two variables being compared. Also, no problems exist when problems should exist.

Comparing B's perceived PSYCH-OPS with A's actual MIL-OPS in the following

manner makes more sense:

$$(\text{perceived PSYCH-OPS}_B \sim \text{MIL-OPS}_A + 2)$$

The two is necessary, for A must allow B to threaten it with escalation. The

magnitude of the constant is, of course, arbitrary.

What results from this equation is a more realistic way of discerning if

PSYCH-OPS are causing a problem. The equation as changed reflects the idea, "Hey,

I'm not doing anything to deserve that kind of retaliation!"

The rest of the arguments about the first weekly problem component hold here,

with whatever changes of variables are necessary.

XPROB (ND, 2) must be rejected as inadequate.

The third weekly problem component concerns CFU levels. Here TEMPER follows

the form suggested earlier--it subtracts A's CFU from A's perception of B's CFU and

uses this difference, DIF, in the following equation.

$$\text{XPROB (ND, 3)} = \frac{\ln{(\text{DIF})} + \text{DIF}^2 + 1}{3}$$

According to the designers, when A's CFU equals the CFU he perceives B to

have, there will be no problem--that is when DIF = 0.

However, note that ln (0) = -infinity. Actually the value of DIF giving

no problem is .347 (by an approximate solution; plug in and try it).

So, the equation does not do what TEMPER says it does (IV-365). In order to

extract any propositions from this equation as it would be necessary to graph it

out. <u>Suffice it to say that the problem is positive above a DIF of .347 and

negative below that value.</u>

For negative DIF we can assume that the program calculates on the basis of

absolute value of DIF, and then subtracts the calculated problem value from zero,

thereby achieving symmetry. But that is no matter, for the equation is invalid.

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One may also attack the notion of using CFU differences here, as this results in meaningless problems. For example:

perceived value of B's CFU	A's CFU
.3	.1
1.6	1.4

If a difference function is used, these pairs of values cause the same problem since B's perceived value minus A's real value are the same.

Yet the problems are obviously not of the same magnitude.

The proposition involved here is that the problem, which we have conceived as the amount by which A wants B to reduce the value of his CFU, is a function of the difference between B's perceived CFU and A's real CFU.

A second proposition is supposed to be nation-groups desire parity in CFU levels with their opponents.

We wish here, then to generate a value of the excess CFU that B has, according to A. If one decides that parity is in fact the desired ratio, then there is no reason why this problem cannot be handled in a manner similar to the bloc leader expenditure problems discussed above, using a "power ratio motivation" of unity. Depending on how ratios are chosen, the result of the problem could be a desired increase in B's CFU.

A neglected factor here is the conflict of B with the third Nation-Group in the conflict region, if there is one. A cannot expect B to reduce CFU for A's sake if B is involved in a war with C. Yet, in the model such a request could arise in bargaining, for weekly bargaining is done in dyads, with no consideration for the third member of the conflict region. CFU differences are considered in the same vacuum.

Taking everything into consideration XPROB (ND, 3), as XPROB (ND, 1) and XPROB (ND, 2) must be considered inadequate as it now stands. The idea behind

these routines is inadequate because third countries are not considered.** Also, the mechanics of the equation and the use of CFU differences rather than ratios combine to make this third weekly problem component unsatisfactory without regard to the context of the calculation.

It is important to note here that problems caused by neutrals are not computed, and problems of neutrals are not computed. Neutrals cannot bargain. But, this restriction does not vitiate the above argument regarding the consideration of the neutral in the CFU problem component, for the suggested factor of war with a neutral is not affected.

The fourth weekly problem component, XPROB (ND, 4) is a function of the value A places on B's land, and the difference between the land fraction that A desires and the fraction that he owns. In other words, the fourth component is the value A places on B's land times the fraction of the conflict region that A would like to add to his holdings. The implied assumption is that A will desire on B's land, and not the land of C, the neutral nation group. For A,

$$\text{XPROB (ND, 4)} = .01 \times \begin{matrix} \text{Value A places} \\ \text{on B's land} \end{matrix} \times \begin{matrix} \text{A's desired} \\ \text{land fraction} \end{matrix}$$

$$- \begin{matrix} \text{A's owned} \\ \text{land fraction} \end{matrix}$$

The .01 is necessary to keep the problem between 0 and 1, for land values range from 0 to over 100. The equation may not exceed 1.

TEMPER calls this problem "desired land." If this problem is to be (a) consistent, and (b) of use in bargaining, we must construe it to represent the

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** Take the reverse of the situation above, for example. A may be conducting war against C, thus needing much CFU, and causing a problem for B. A could then offer to eliminate B's problem in return for a concession on a problem B is causing A, and thus sabotage his own war effort!

problem that B's desired land fraction is causing for A. _The problem that B's_
desired land fraction causes for A is a function of the value A places on B's land,
and the difference between A's desired and owned land fraction (fraction of the
conflict region). This problem is not a function of B's desired land fraction!
That is, the problem caused by B's desired land fraction is independent of the
cause of the problem, B's desired land fraction.

This clearly is a reversal, yet it is exactly what volume four says, checked
in four different places in PROREC and BARGY.

The other three weekly problem components are problems of A caused by B and
this one should be too. There is not way of reinterpreting the subscripts in the
TEMPER equation (IV-367) that allows the desired sense to be made out of it so we
must evaluate XPROB (ND,4) as unacceptable. In bargaining, a nation-group makes
an offer by reducing a particular problem he sees himself as causing his opponent.
The N.G. tests an offer by taking the offered reduction in value and seeing if it
reduces his problem. As B can do nothing to reduce A's fourth problem component,
nothing good or bad will happen to this problem--it must remain untouched. As the
sum of all four problems is used to calculate escalation, this error should be
cleared up, or the component eliminated.

In summary, TEMPER proposes that there are four "problems" that a nation group
will desire to reduce through bargaining. These problems are supposedly caused by
the opposing bloc member's MIL-OPS, PSYCH-OPS, CFU value, and desired land fraction.
Neutrals neither cause nor have problems and do not bargain. As a first approxima-
tion, the limitation of bargaining between conflict-region opponents, to these four
variables appears reasonable enough, as these four problems cover the military
situation rather completely. There are perhaps some special problems, such as
result from a desire for an independent nuclear force, that may exist in the real

world but are not included in TEMPER. The entire model is rather static, <u>as changes</u> <u>of kind in the state of the world are ignored in favor of changes in degree.</u>

We have seen, however, that all four weekly problem components that are computed for intra-bloc bargaining are in need of serious revision for many different reasons. Most propositions in this part of the routine are not well thought through, as but a brief consideration of the problems resulting from reasonable inputs will show. It must be concluded that these problems have little influence on the model. It must be considered, then, whether the weekly problems should be retained in any form.

PROREC does one more thing. It computes the problems that nation-group A percevied it is causing nation-group B in the conflict region. The same formulas are used here as are used to compute weekly problem components. Appropriate perceived and actual variables are used. For example, for the first problem component that A perceived himself as causing for B, the equation used is the equation for A's own second problem component.

We need not discuss these propositions here, for they are substantially the same as just discussed and all criticisms of the weekly problem components apply here.

The perceived weekly problem components are used by a nation-group for testing the effects of offers it makes to its opponent.

WEBARG

WEBARG does nothing except set up all the problems calculated in PROREC for use in BARGY.

BARGY

In BARGY, bargaining nation groups compare their problems and offers are made
and accepted. There are no equations and no functional relationships. All proposi-
tions are implied. There are only comparisons and data manipulations. The effects
of offers on perceived problems are calculated using the equations in PROREC. If
these equations are valid, then any bargaining made will reflect the decision
criteria in BARGY. Many of these equations have been demonstrated to be invalid.
The output from BARGY will thus suffer accordingly.

BARGY conducts weekly and annual bargaining. Annual bargaining is conducted
on the following four problems, and is done for bloc leaders only:

(1) Military spending
(2) R and D spending
(3) Strategic spending
(4) Tactical O and M spending

Weekly bargaining is conducted in all conflict regions having a member of both
Eastern and Western blocs. The problem components bargained over are:

(1) problem caused by opponent's MIL-OPS
(2) problem caused by opponent's PSYCH-OPS
(3) problem caused by opponent's CFU
(4) problem caused by opponent's desired land fraction
    (the fraction of the conflict region the opponent
    desires to own).

We shall for now assume that the weekly problems are validly computed and consider
the routine in which they are used.

It is unnecessary to differentiate between these two arrays. They are effective-
ly the same for purposes of bargaining, for the only important feature of these
arrays is that each is composed of four problems.

There are many details in BARGY that are not clear in the TEMPER documentation.
We shall therefore discuss BARGY in rather general terms.

In a bargaining situation, either annual or weekly, the two nation-groups face each other with their bargaining arrays.
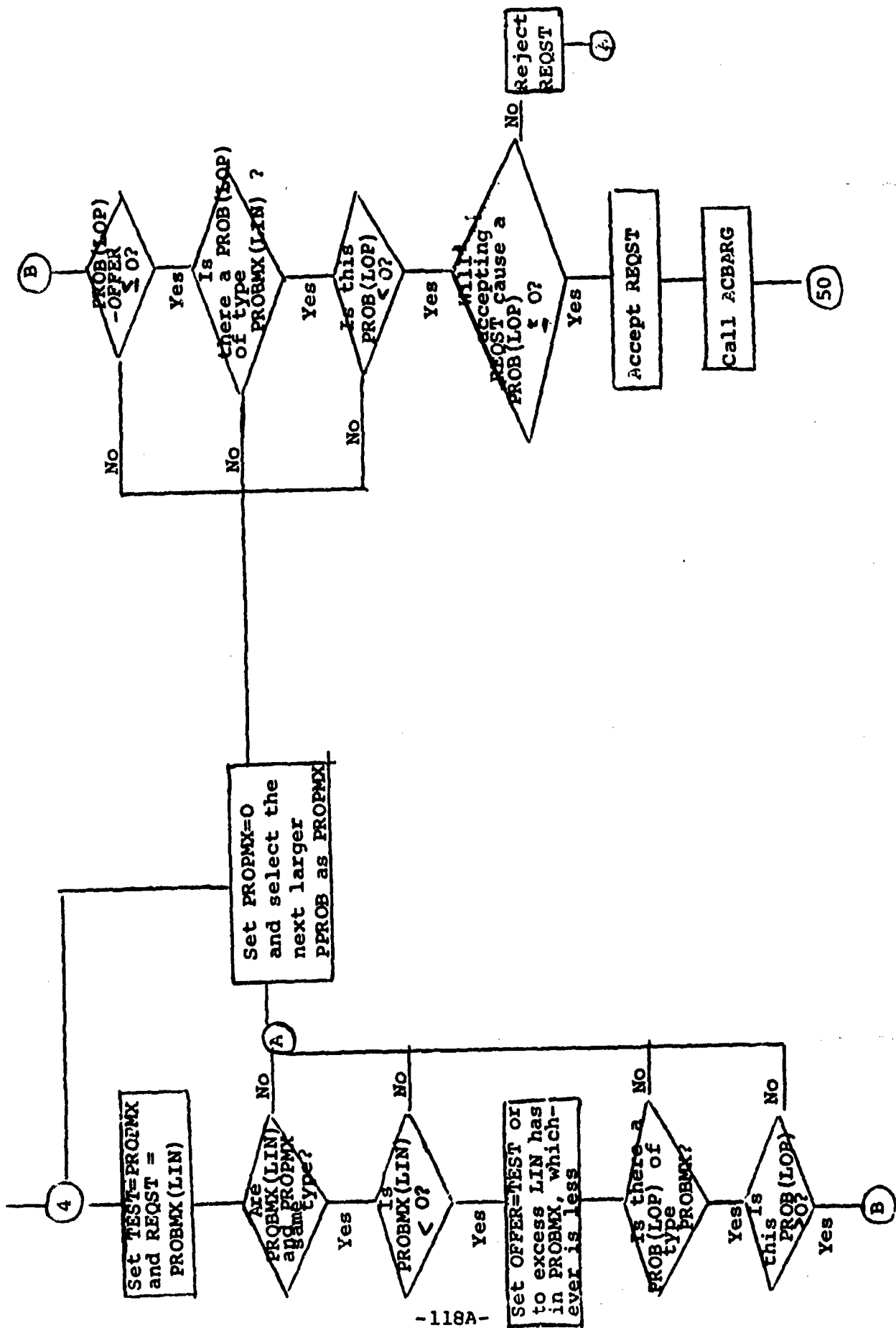
On the following page is a flow diagram of the bargaining process. It is difficult to explain how bargains are made without it, for there are enough branch points in the process to make it almost unintelligible in a written description. The flow chart in Vol. IV (p. 387) is slightly different and has enough errors (misprints and scrambled wording) to be unusable. This flow chart holds for weekly bargaining. There are a few additions in yearly bargaining between bloc leaders.

(1) The initial offers and request (STEPS 5 and 6) are divided by the appropriate perceived and real power ratio motivations, respectively, if the offers and/or requests concern R and D, strategic, or tactical O and M spending. See IV-385, footnote. Why this is done in not clear. However, it has an interesting and realistic result, and perhaps that was the reason. The result, given the range of power ratio motivations (Soviet values will always be less than 1, American values greater than 1) is that American offers will always be larger than the perceived problem, American requests will always be smaller than the real problem; Soviet offers will always be smaller than the perceived American problem and Soviet requests will always be larger than their problems, for these three annual problem components.

As offers must be tested by the opponents and there is no evidence that anything special is done at this time (STEP 8), the effects of this division by power ratio motivations are attenuated but not canceled.

(2) When the opponent tests the offer (STEP 10), he first multiplies it by the appropriate power ratio motivation he perceives the opponent to have. Soviets will thus make the offer larger, Americans smaller, which is unrealistic.

The ultimate (and now unrealistic) effect of these multiplications and divisions seems to be to make it easier for a bargain initiated by the U.S. to be accepted.

Set TEST=PROBMX and REQST = PROBMX(LIN)

4

Are PROBMX(LIN) and PROBMX same type? — Yes / No

Is PROBMX(LIN) < 0? — Yes / No

Set OFFER=TEST or to excess LIN has in PROBMX, whichever is less

Is there a PROB(LOP) of type PROBMX? — Yes / No

Is this PROB(LOP) ≤ 0? — Yes / No — B

A

Set PROPMX=0 and select the next larger PPROB as PROPMX

PROB(LOP) -OFFER ≤ 0? — Yes / No — B

Is there a PROB(LOP) of type PROBMX(LIN) ? — Yes / No

Is this PROB(LOP) < 0? — Yes / No

Will accepting REQST cause a PROB(LOP) ≤ 0? — Yes / No — Reject REQST

Accept REQST

Call ACBARG — 50

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If Americans make offers that are larger than the problem they perceive, and the Soviets take these offers and consider them larger still, then they are likely to accept. If Americans make their requests smaller than their problem, the same holds. If Soviet offers are made smaller than perceived problems, and Soviet requests larger than actual problems then it is unlikely that a bargain will be made. This is because, as the flow chart shows, a condition on the acceptance of a bargain is that the offer must erase the opponent's problem, and a request must not cause the opponent a problem where none existed before.

A further set of conditions is that the request must eliminate the requester's problem, and the offer must not create a new problem for the offerer.

In other words, for a bargain to be accepted, no new problems can be created, and each nation-group must have a problem eliminated. Another proposition here is that bargains may be made over the same or over different variables.

The latter conditions are sensible in principle but too strong. It is unlikely that a nation-group will make a bargain that will cause it a new problem, though if it is able to make a sufficient net gain, why not?

Net gains could easily be calculated by summing the problem array.

It is also unrealistic to postulate that a nation group will always demand the elimination of an entire problem. If it perceives that it is getting the better of the deal, what more could it ask? The criterion for the acceptance of a bargain should be that each nation-group perceive that it is getting the better of the deal, in terms of reduction in the magnitude of the sum of the four problem components, with perhaps an ξ (minimum) gain if it is to trade one problem for another.

Finding such bargains is, however, a very difficult process mathematically. The bargaining routine would have to be completely rewritten to incorporate some

econometric models.

The bargaining routine as it now stands will not make bargains that correspond to the bargains that might be made in the real world. The relationship of bargains to threat, hostility, likelihood of mutual damage through conflict, desire for war or external dynamism, suspicion of the enemy's motives, evaluation of the likelihood that he will live up to his agreement, intention of living up to the agreement yourself, and similar things is not clear here. Isolating any of these factors that exist in TEMPER is impossible without simulate data, for no relations of this type are explicitly programmed in TEMPER. This is perhaps most important with regard to intentions and expectations of the Nation-Groups. It is assumed in TEMPER that Nation-Groups will live up to their bargains; and they do, in TEMPER, if not the real world.

There is one exception to the rule that TEMPER Nation-Groups will live up to their bargains, and it will be discussed under ACBARG.

Propositions regarding which problem components are most likely to be involved in a bargain are difficult to make. We do not perceive any differences here, because offers and requests must be tested by both sides. Note, though, that is possible for one Nation-Group to get the better of a bargain in terms of reduction of total problem. This is because it is not necessary that a Nation-Group perceive that it is getting the better of the bargain.

ACBARG

ACBARG is called to consummate bargains reached in BARGY. Usually it will do this by reducing the proper variables in the problem equations the necessary amount.

If a weekly bargain has been made over CFU, however, there is a routine for deciding whether the bargain will in fact be carried out. A Nation-Group will only make an agreed reduction in CFU to the extent that it can do it with exogenous forces deployed within it.

The Nation-Group must live up to some part of the bargain regarding CFU, but it does not have to be a large part.

There is a four-step routine to decide whether or not a bargain involving CFU is accepted.

(1) If the NG who is to reduce his CFU has no exogenous forces deployed in it, it rejects the bargain.

(2) If it has such forces, it then computes the sum of the military coercion motivations of all NG's which have loaned it CFU multiplied by the fraction of the CFU in that Nation-Group that they own:

$$\text{ZMILC (N)} \quad \times \quad \frac{\text{CFU in NG owned by N}}{\text{CFU in NG}}$$

If this sum is less than the military coercion motivation of the NG concerned, then the bargain is accepted. If not, the third step is calculated.

(3) The sum of the weighted military coercion motivations of those helpers whose ZMILC is lower than the NG are compared with the sum of those helpers whose ZMILC is larger. If the sum of those with smaller ZMILC is larger than the sum of the helpers with larger ZMILC, the bargain is accepted. If not, continue.

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(4) The N.G. will compare the sum of the ally value he has awarded to those helpers whose ZMILC is less than his with the ally value he has awarded these helpers with larger ZMILC. If the sum for those helpers whose ZMILC exceeds his is larger than the sum for the others, the bargain is rejected.

The acceptance of a bargain requiring a reduction in CFU depends on the military coercion motivations of those allies who have loaned the bargainer CFU, and the fraction of the bargainer's CFU that they own. The higher their military coercion motivations are and the more CFU they have loaned, the more likely they will be to force rejection of the bargain.

Reduction in CFU can only be done by returning exogenous forces. If such a bargain is accepted it is met only so far as it can be met by the return of exogenous force.

If the bargain is accepted and sufficient exogenous CFU is available to meet it, then the CFU of those allies with the lowest ZMILC will be returned first. CFU will be returned only to those allies who have a military coercion motivation lower than that of the bargainer. Thus a Nation-Group can force the bargainer to keep CFU he wants to return.

Allies who have loaned CFU retain some control over whether the aided can return it because of a bargain. They thus exert some control over whether any bargain is reached, though the extent of this influence cannot be determined.

The rest of ACBARG is concerned with carrying out bargains that have been made. This is done through changing the problem causing variables in the problem equations. These calculations are of algebraic interest only. The equations are no better than they were in PROREC.

BUDGET

Subroutine BUDGET calculates the fraction of the government budget desired for military spending, and it calculates for strategic weapon owners the fraction of the military budget desired for R and D and for strategic spending. Tactical forces get what is left. These calculations are done on the basis of economic variables and discrepancies between desired and actual expenditures left over from the previous year. These equations then are primarily economic. <u>One proposition of note is that tactical forces get what is left over after R and D and strategic forces spending are computed.</u>

CDALC

Escalation and termination of war is computed in CDALC. CDALC is perhaps the most poorly explained of all TEMPER subroutines. Almost no explanation is given for it, and the discussion is limited to giving the equations and naming the variables. The equations are exceptionally complex being surpassed in complexity only by those in WINIT.

CDALC examines each war--by which is meant MIL-OPS of 6 or above. For each warring Nation-Group it calculates the "disutility" of the war. "As soon as the size (of disutility) is less than the smoothed value over time, implying the war is reaching either stalemate or defeat, a change in behavior is recommended. If the nation had last excalated, it will now de-escalate and visa-versa." (sic!)

Disutility is the sum of the following terms:

(1) "the problem", the total weekly problem of the N.G. in question.

(2) 100 times the total losses in the war to date. This is figured in the military submodel.

(3) eight times the current cost of operating all forces engaged in the war, including exogenous forces.

(4) -1/2 times the N.G.'s military coercion motivation times the difference of its MIL-OPS level and the MIL-OPS level it perceives for its opponent.

The disutility of the war therefore increases with the "problem" the N.G. has, the cumulative losses the war has inflicted on the N.G., the current cost, and the fourth term. We may make the fourth term positive by reversing the difference so that it is perceived opponent MIL-OPS minus own MIL-OPS. The "disutility increases if the opponent is perceived to have the higher MIL-OPS level, and decreases if the N.G. under consideration has the higher MIL-OPS level. In the former case the "disutility" will be larger as the N.G.'s military coercion motivation becomes larger. In the latter case, the reverse.

The "disutility" is added to last week's value of "disutility" and the sum is divided by two. This is the "smoothed disutility."

War is automatically escalated if it is one month old or less.

The "escalation key," a measure of how much to escalate, is set. If the war is a month old or less, the "escalation key" is set to unity. The amount of escalation is set to 1/10. Present MIL-OPS is added to .1, and if this sum is less than 10 the escalation is effected. If it is 10 or more, nuclear war occurs and the simulation is over. This is unlikely in TEMPER. We may safely assert then that a war is escalated by .1 each week it is a month old or less.

What an escalation of .1 means is not clear. It is of course an addition to ZDOMZ, the MIL-OPS level.

If the war is more than a month old, a new "escalation key" is set on the basis of the old one times the sine of the difference between the current and the smoothed value of disutility. There are four possible situations:

TABLE

Disutility-smoothed Disutility	Last week's action	This week's action
greater than 0	escalation	escalation
greater than 0	de-escalation	de-escalation
less than 0	escalation	de-escalation
less than 0	de-escalation	escalation

The propositions regarding this table have been quoted above.

A nation-group will change its strategy (escalation or de-escalation) if it perceives that the war is turning against it. The magnitude of the change is a function of last week's magnitude of escalation or de-escalation, and the difference of this week's "disutility" and the "smoothed disutility."

The next thing that CDALC does is decide whether or not to terminate the war. This is done by comparing losses with gains and ZEAL, the "zeal with which the war is waged," for both nation-groups. This ZEAL is independent of the "disutility" calculated earlier. The GAIN is computed by multiplying the net advance of the war, in terms of the fraction of the conflict region that the N.G. has added (or lost) in his holdings during the war, multiplied by the value the N.G. places on his opponent's land. There is a third factor which is used to take account of the fact that only one value of the advance is computed. Because of this, the value of an actual advance for one of the two warring Nation-Groups will be negative. The third factor manipulates the sign of gain appropriately. The ZEAL variable is complex. There are four factors: two exponential terms, ZMILC, and a constant. The constant is .6 at the moment. The second term is the negative exponential function of the age of the war in weeks divided by 100. This factor varies from approximately one in the first week of the war to about .37 when the war is 100 weeks old. ZEAL, then, decreases as the war gets older. The last term is

$$(1 - e^{-x})$$

where "x" is four times the ratio of the Nation'Group's losses in the war to his GNP.

Several propositions are important here. First, ZEAL increases as losses increase, for as losses increase the ratio increases; as the ratio increase, e^{-x} decreases, and $1 - e^{-x}$ increases. At the same time, ZEAL increases as GNP decreases. These propositions represent mistakes. The function should be e^{-x} and not $1 - e^{-x}$. The decision to terminate a war is a function of decreasing ZEAL, which decreases with the length of the war and with increases in GNP. Note, however, that both the exponential terms are less than unity, as is the constant.

The fourth term is the military coercion motivation of the Nation-Group. ZEAL will be a fraction of this motivation (ZMILC).

It should be noted that the "total losses" used in ZEAL are the dollar value of the tactical forces lost. Population losses are not considered here at all.

The decision to terminate a war is made if for both warring Nation-Groups the sum of GAIN and ZEAL does not exceed the dollar value of total tactical force losses, in billions of dollars. The likely range of these three variables is not clear. We suspect that tactical force losses would have to be rather high, gains and land value rather low in order to terminate a war.

The error, which makes ZEAL increase with tactical force losses should, if losses are high, have a reasonably small effect. But, this makes it more difficult to terminate a war. At any rate, this makes the relationship between GAIN, ZEAL, and losses non-linear.

Termination of a war can happen if the dollar value of land gained, plus the ZEAL factor, is exceeded by the dollar value of the tactical forces lost. Because tactical force losses appear on both sides of the comparison, the functional relationship between tactical force losses and the other variables is unclear. One can only state the above propositions.

If a war is terminated, MIL-OPS are set back to five for both Nation-Groups. If we take the interpretation of MIL-OPS given in Vol. III, p. 359, this means

that when a war is terminated, the combatants continue to fight a rather major guerilla war against each other. This is rare. (See IV-425).

The ending of a war by the standards described above is somewhat simple. War is likely to end if losses of tactical force are high and the value of land gains is low, the length of the war is considerable. The war is not likely to be terminated if it is reasonably new and losses are small, even if there have been no land gains.

Two factors missing in this decision routine for war termination are population losses and external peacemaking. Capital wealth depreciation is another factor which might be important. The implied proposition in the routine is that the decision to terminate a war is made on the basis of cost and desire considerations of the two Nation-Groups involved. Allies who have loaned forces to the principals have no say in war termination, and there is no external organization that can exert an influence towards the termination of conflict.

CDALC continues to consider conflict at a MIL-OPS level less than 6. Its first checks for a crisis. A crisis is a problem that has changed in the past week more than a threshold level. It calculates the ratio of this week's to last week's weekly problem (the sum of the four weekly problem components). If the ratio exceeds the threshold, a crisis exists. If not, the situation is considered only a problem. There are, then, three kinds of conflict situation: war, crisis, and problem. Having noted any crises that exist, CDALC calls WINIT to decide whether or not to escalate conflicts which are less than war (MIL-OPS below 6).

WINIT

In WINIT, TEMPER gives its most striking example of over-complexity. WINIT does nothing more than decide whether to escalate, de-escalate, or maintain present levels of MIL-OPS and PSYCH-OPS. The calculations are of unparalleled complexity, and we shall not discuss them fully.

The decision to escalate MIL-OPS is a function of the following terms:

(1) The difference between the desired and the presently held fraction of the conflict region, multiplied by the value of the opponent's land, multiplied by a probability of winning a war against the opponent. This probability is a function of CFU differences in the conflict region and CFU differences summed over the blocs. No indication is given of how these sums are handled if one of the two conflicting Nation-Groups is a neutral. For neutrals do not aid each other, and bloc members do not give aid to allies warring against neutrals.

(2) Subtracted from this term is the potential loss, measured by the difference between the opponent's perceived desired land fraction and his present land fraction, multiplied by the value the N.G. places on his own land, multiplied by one minus the probability of winning as computed for the first term.

(3) Also subtracted is a term that represents the potential loss due to nuclear retaliation. It is a function of population losses and the probability of nuclear war. The factors in this term are: one plus the hyperbolic tangent of the perceived opponent MIL-OPS level plus own PSYCH-OPS level minus 10.0; the N.G.'s credibility of nuclear war parameter used in THREAT; population loss ratio if the opponent bloc pre-empts; a scaling constant; and, an approximate value of an incomplete beta integral.

The terms of the beta function are not simple, and three pages of the documentation are given to explaining them. We find it completely impossible to trace

out the effects on the term of the var'ous inputs to the beta function. All the variables that are combined in a complicoted manner for use in the beta integral appear also in other factors of this term.

(4) Subtracted also is the fourth term, which represents the risk of conventional retaliation. It is a constant multiplied by the negative exponential function of: perceived opponent PSYCH-OPS plus own MIL-OPS minus 10, all divided by two.

We have criticized this argument before, in PROREC. The propositions implied by it are given in the discussion of weekly problem components, and it is unnecessary to repeat them here.

(5) The fifth term is also negative and is a threshold, THRESH, which is used to give a range of values of this whole big equation within which neither escalation nor de-escalation will be caused. It is a function of the military coercion motivations.

(6) A stochastic factor which is equally likely to have a value above or below zero. It is used to account for unpredictable or unaccountable variables.

It is impossible to compare the relative importance of these terms. There is no reason to believe that the third term will give any improvement over some simple function of strategic threat to the N.C. as calculated in THREAT; and it is this third term that is most complex. The fourth term is unacceptable. The reasons are given in PROREC. The rest of the terms make sense as bookkeeping.

There are no specific propositions here, because of the use of the same variables in different terms and in different factors of the same term. MIL-OPS levels are used in the 5 or 6 places, for example. The only possible proposition would relate the six terms to the general decision to escalate. As it is not possible to assess the relative importance of each term, and it is far from clear what they each represent (as distinguished from what they are called), no propositions are possible

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here either.

All one can say is that the decision to escalate, de-escalate, or do nothing is a function of land values, desires for land, MIL- OPS and PSYCH-OPS levels, population loss fractions, credibility of nuclear war, CPU of the combatants and their blocs, weekly problems, and a host of parameters. The effects on the escalation decision of any important variable cannot be traced.

The decision to escalate PSYCH-OPS is a function of the weekly problem size, the beta integral computed above, and a few other factors. The whole thing is complex enough to be unintelligible even though it is only one term. Perhaps it will be best for the reader if we try to state just this equation in terms of the variables considered as input by WINIT.

CDALC is called once the decisions to escalate or de-escalate have been made. It computes the magnitude of escalation. If the situation is a crisis, PSYCH-OPS are raised by 1, left the same, or lowered by 1 depending on the decision of WINIT. MIL-OPS are raised or lowered by .05, or left the same, according to the decision calculated in WINIT.

If the situation is only a problem, the PSYCH-OPS are raised or lowered by the cube root of the weekly problem or left unchanged; MIL-OPS are raised or lowered by .05 times the cube root of the problem, or left unchanged. Both changes are dependent on the decision calculated in WINIT.

There are no particular propositions here. The size of the escalations is rather arbitrary. Weekly changes in PSYCH-OPS are, however, large; weekly changes in MIL-OPS are small. This makes some sense, as it is easy to threaten, but changes in MIL-OPS cannot take place too rapidly.

As we are concerned here with conflict below the level of war, it is difficult to imagine how such conflict could escalate very rapidly. Were it easy to give some simple interpretation to the weekly problem size, some proposition about the magnitude

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of escalation in a problem situation could be attempted.

The WINIT subroutine points out how complex TEMPER is. Except for MIL-OPS and PSYCH-OPS and a few other variables, just about any variable could probably be doubled with little effect.

The point is that there are so many variables, so tightly interrelated, that in any given equation, no single TEMPER variable accounts for much of the variance. Take for example, the third weekly problem component, discussed in PROREC. The fact that the equation does not do what the designers wanted is unimportant, for the error did not prevent people from running the simulation and making some sense out of the results. There have been many variables shown to be defined in an unsatisfactory manner. Important factors are left out here and there. But, except for the motivations, and even here it is only the input values that count, no variable is very important. Double the procurement cost of tactical air wings, update ZMILC from 7.05 to 7.12 because of a change in the weather and little will happen to affect the plausibility of the simulation output. There are whole terms in equations that could be left out with little effect. It was shown in PERCEP and ZPERCE that some of the variables were bound to be perceived accurately no matter what, although the designers did not intend this. And yet it went unnoticed because it had so little effect. In this sense, TEMPER is an accomplishment, for despite all the errors, the model produces output that is a plausible, if not probable representation of what might happen. One may be sanguine about TEMPER. For if the obvious errors are changed, a few equations simplified, and some others expanded, TEMPER should become a useful analytic device.

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13. ABSTRACT

This report is an evaluation of the TEMPER model as a representation of, and a tool for, the analysis of international relations. The major assumptions implicit in the model were examined and assessed to determine their degree of scientific validation, relevance to problems of crisis management, and relevance to decisions of the U.S. and the Department of Defense. Equations and computer routines dealing with political aspects of the model were analyzed. Recommendations were made to eliminate, modify or combine routines, correct errors and ambiguities, and simplify propositions embedded in the model. Strengths and novel features of the TEMPER design were also identified.

The most radical recommendation in this report is to transform TEMPER into a family of partial models for man-machine interaction in the analysis of international crisis. Time-sharing now makes this practicable. TEMPER is potentially a powerful device for the study of international relations.

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